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NATIONAL DAM INSPECTION PROGRAM. INDIAN LAKE DAM (NDI I.D. PA-0--ETC(U)
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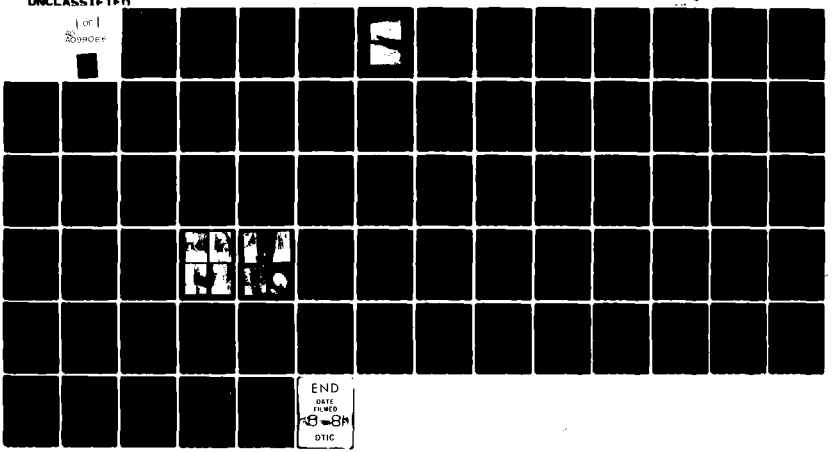

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SUSQUEHANNA RIVER BASIN
WHITE CREEK, SUSQUEHANNA COUNTY

PENNSYLVANIA

(6) National Dam Inspection Program.

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ELECTE
MAY 1 8 1981

INDIAN LAKE DAM

(NDI I.D. PA-ØØ57
DER I.D. Ø58-038)

~~OWNER, MR. ALFRED W. ANTONE~~

Susquehanna River Basin, White Creek, Susquehanna County, Pennsylvania

PHASE I INSPECTION REPORT
NATIONAL DAM INSPECTION PROGRAM

(11) 19 Mar 81

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PREPARED FOR

DEPARTMENT OF THE ARMY
BALTIMORE DISTRICT, CORPS OF ENGINEERS
BALTIMORE, MARYLAND 21203

BY

(15) DACW 31-81-C-0019

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PREFACE

This report is prepared under guidance contained in the Recommended Guidelines for Safety Inspection of Dams, for Phase I Investigations. Copies of these guidelines may be obtained from the Department of the Army, Office of Chief of Engineers, Washington, D.C. 20314.

The purpose of a Phase I investigation is to identify expeditiously those dams which may pose hazards to human life or property. The assessment of the general condition of the dam is based upon visual observations and review of available data. Detailed investigations and analyses involving topographic mapping, subsurface investigations, material testing, and detailed computational evaluations are beyond the scope of a Phase I investigation; however, the inspection is intended to identify any need for such studies which should be performed by the owner.

In reviewing this report, it should be realized that the reported condition of the dam is based on observations of field conditions at the time of inspection along with data available to the inspection team. In cases where the reservoir was lowered or drained prior to inspection, such action, while improving the stability of the dam, removes the normal load on the structure and may obscure certain conditions which might otherwise be detectable if inspected under the normal operating environment of the structure.

It is important to note that the condition of the dam depends on numerous and constantly changing internal and external factors which are evolutionary in nature. It would be incorrect to assume that the present condition of the dam will continue to represent the condition of the dam at some point in the future. Only through frequent inspections can unsafe conditions be detected and only through continued care and maintenance can these conditions be prevented or corrected.

Phase I inspections are not intended to provide detailed hydrologic and hydraulic analyses. In accordance with the established Guidelines, the spillway design flood is based on the estimated "Probable Maximum Flood" for the region (greatest reasonably possible storm runoff), or fractions thereof. The spillway design flood provides a measure of relative spillway capacity and serves as an aid in determining the need for more detailed hydrologic and hydraulic studies, considering the size of the dam, its general condition and the downstream damage potential.

The assessment of the conditions and recommendations was made by the consulting engineer in accordance with generally and currently accepted engineering principles and practices.

PHASE I REPORT
NATIONAL DAM INSPECTION PROGRAM

NAME OF DAM: Indian Lake Dam
STATE LOCATED: Pennsylvania
COUNTY LOCATED: Susquehanna
STREAM: White Creek, tributary of Meshoppen Creek
SIZE CLASSIFICATION: Small
HAZARD CLASSIFICATION: Significant
OWNER: Mr. Alfred W. Antone
DATE OF INSPECTION: November 14, 1980 and February 4, 1981

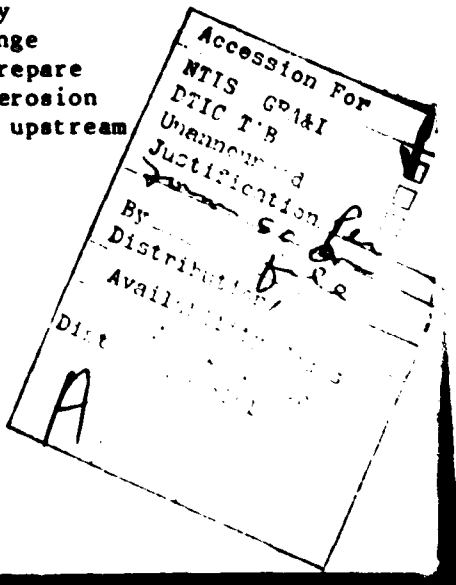
ASSESSMENT: Based on the evaluation of existing conditions, the condition of Indian Lake Dam is considered to be poor. This dam appears to be essentially abandoned and is not being maintained. Upstream and downstream faces are covered with thick brush which precluded adequate inspection. Concrete in the spillway structures has seriously deteriorated. The low level outlet facilities do not appear to be functional.

The spillway capacity was evaluated according to recommended criteria and found to be inadequate. According to the recommended criteria, small dams in the significant hazard category are required to pass from the 100-year flood to one-half the Probable Maximum Flood (PMF). Because the height of the dam approaches intermediate size, one-half PMF is selected as the spillway design flood. The flood discharge capacity was evaluated according to the recommended procedure and was found to pass only 10 percent of the PMF without overtopping the dam. Therefore, the flood discharge capacity of the dam is classified to be inadequate.

The following recommendations should be implemented as soon as possible or on a continuing basis.

1. The owner should determine the nature and extent of improvements required to provide adequate spillway facilities.

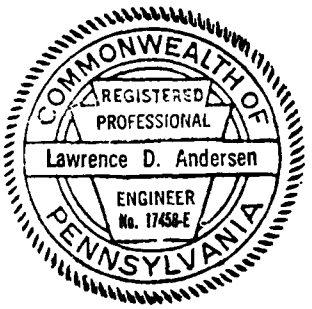
2. In conjunction with the above work, investigations should be undertaken to determine the effects of concrete cracking and deterioration on the structural adequacy of the spillway structure, to evaluate erosion in the plunge pool at the toe of the spillway, and to prepare and execute plans for providing adequate erosion protection at the spillway toe and on the upstream slopes of the embankment.



3. The owner should confirm the operational condition of the outlet works and perform necessary maintenance, if found inoperative.

4. Around-the-clock surveillance should be provided during unusually heavy runoff and a formal warning system should be developed to alert the downstream residents in the event of an emergency.

5. The owner should develop a formal operating and maintenance plan for the dam, inspect the dam regularly and perform necessary maintenance.



Lawrence D. Andersen, P.E.
Vice President

March 19, 1981
Date

Approved by:

JAMES W. PECK
Colonel, Corps of Engineers
District Engineer

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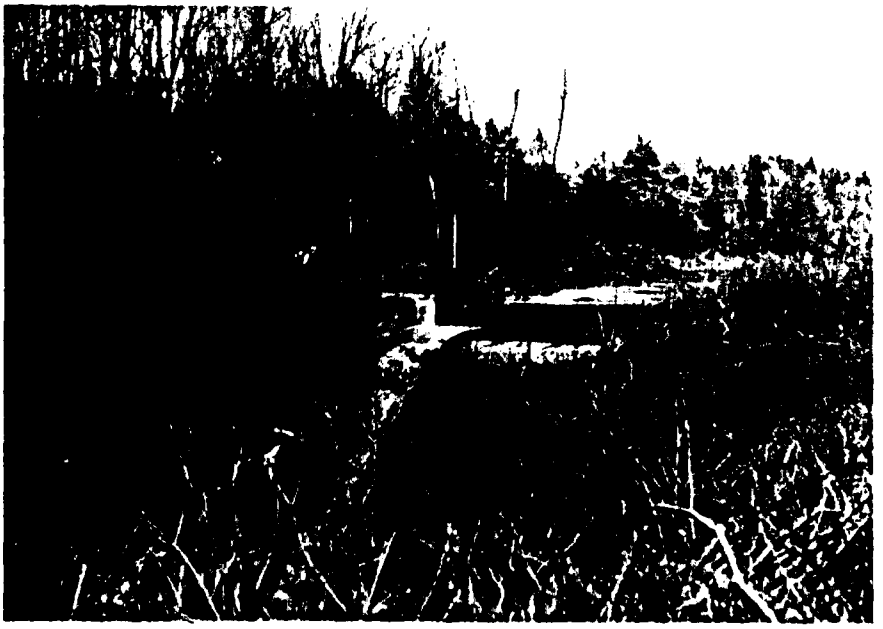
Date

INDIAN LAKE DAM
NDI I.D. PA-0057
DER I.D. 058-038
NOVEMBER 14, 1980

Upstream Face



Downstream Face

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PHASE I REPORT
NATIONAL DAM INSPECTION PROGRAM
INDIAN LAKE DAM
DER I.D. 058-038
NDI I.D. PA-0057

SECTION 1
PROJECT INFORMATION

1.1 General

a. Authority. The inspection was performed pursuant to the authority granted by The National Dam Inspection Act, Public Law 92-367, to the Secretary of the Army, through the Corps of Engineers, to conduct inspections of dams throughout the United States.

b. Purpose. The purpose of this inspection is to determine if the dam constitutes a hazard to human life or property.

1.2 Description of Project

a. Dam and Appurtenances. Indian Lake Dam consists of a concrete ogee-type gravity spillway structure flanked by earth embankments on each side. The dam is approximately 260 feet long with a maximum height of 39 feet from the downstream toe and a crest width of 10 feet. The upstream side of the dam is protected by a small amount of riprap and the downstream slope is covered with small trees and brush. The flood discharge facilities for the dam consist of the ogee spillway located at the center of the embankment. The spillway consists of a 17-foot-long central low flow section plus two 10-foot sections on each side, one foot above the low flow section. The spillway discharges into a plunge pool at the toe of the dam which discharges through an earth channel downstream. The outlet facilities consist of a 15-inch-diameter cast iron pipe extending through the spillway structure. The flow through the outlet pipe is controlled by a gate valve at the upstream face of the spillway and is operated by a valve stem enclosed in a gate chamber extending to crest level. This outlet facility constitutes the emergency drawdown system for the reservoir.

b. Location. Indian Lake Dam is located (N41° 45.5', W75° 55.5') on White Creek, a tributary of Meshoppen Creek in the southwestern part of Bridgewater Township, Susquehanna County, Pennsylvania. Plate 1 illustrates the location of the dam.

c. Size Classification. Small (based on 39-foot height and 219 acre-feet storage capacity).

d. Hazard Classification. The dam is classified to be in the significant hazard category. Below the dam, White Creek flows about

one-quarter mile to a highway where it flows through a 13-foot-diameter culvert. There are no structures on the floodplain throughout this reach. For the rest of its course the stream meanders downstream to its confluence with Meshoppen Creek. There are two houses and one mobile home in the first three-mile reach of the floodplain downstream from the dam. In the event of a dam failure, it is estimated there would be significant economic damage in this reach and the loss of a few lives is considered possible.

e. Ownership. Mr. Alfred W. Antone, Indian Lake, Dimock, Pennsylvania 18816.

f. Purpose of Dam. Recreation.

g. Design and Construction History. The dam was designed by Franklin and Company, Civil Engineers, from Philadelphia, Pennsylvania. Construction of the dam was completed in 1916.

h. Normal Operating Procedure. The reservoir is normally maintained at the spillway crest level (Elevation 1390, USGS Datum), leaving 4.2 feet of freeboard to the top of the dam at Elevation 1394.2. All inflow occurring when the reservoir level is at the spillway crest elevation or above is discharged over the uncontrolled spillway.

1.3 Pertinent Data. Elevations referred to in this and subsequent sections of the report were calculated based on field measurements, assuming the low flow section of the spillway to be at Elevation 1390 (USGS Datum), which is the elevation shown as the normal pool elevation on the USGS 7.5-minute Montrose West quadrangle.

a. Drainage Area	2.2 square miles[1]
b. Discharge at Dam Site (cfs)	
Maximum known flood at dam site	Unknown
Outlet conduit at maximum pool	Unknown
Gated spillway capacity at maximum pool	Not applicable
Ungated spillway capacity at maximum pool	842
Total spillway capacity at maximum pool	842
c. Elevation (USGS Datum) (feet)	
Top of dam	1394.2
Maximum pool	1394.2
Normal pool	1390.0
Upstream invert outlet works	1359 (estimated from design drawings)

[1] Planimetered from USGS topographic map. State records indicate the drainage area to be 2.1 square miles.

Downstream invert outlet works	1358
Maximum tailwater	Unknown
Toe of dam	1355

d. Reservoir Length (feet)

Normal pool level	1100
Maximum pool level	1400

e. Storage (acre-feet)

Normal pool level	153
Maximum pool level	219

f. Reservoir Surface (acres)

Normal pool level	11.9
Maximum pool level	19.0

g. Dam

Type	Earth embankment with concrete gravity spillway.
Length	260 feet
Height	39 feet
Top width	10 feet
Side slopes	Downstream: 1.5H:1V; Upstream: Not determinable
Zoning	No
Impervious core	Mixture of coarse gravel, fine gravel, sand, and clay.
Cutoff	Cutoff trench filled with same material as used for core.
Grout curtain	No

h. Regulating Outlet

Type	15-inch-diameter cast iron pipe
Length	110± feet (measured from design drawings)
Closure	15-inch gate valve
Access	Gate chamber
Regulating facilities	Gate valve

i. Spillway

Type	Ogee-type concrete structure
Length	37 feet (perpendicular to flow)
Crest elevation	1390.0 (low flow)
Upstream channel	Lake
Downstream channel	Earth channel

SECTION 2
DESIGN DATA

2.1 Design

a. Data Available. The available data consist of files provided by the Commonwealth of Pennsylvania, Department of Environmental Resources (PennDER), which contain design drawings, correspondence and inspection reports.

(1) Hydrology and Hydraulics. Review of the information in the Commonwealth of Pennsylvania files showed that there are no original hydrology and hydraulic design data available for the dam. However, a state inspection report entitled "Report Upon the Application of Dr. George W. Norris," dated June 26, 1915, contains the criteria used to size the spillway.

(2) Embankment. The available information consists of design drawings.

(3) Appurtenant Structures. The available information consists of design drawings.

b. Design Features

(1) Embankment. As designed, the earth-fill sections of the dam are homogeneous fill with a puddle clay core along the center line of the embankment, extending for the full length of the earth sections. The puddle clay core starts two feet below the crest of the dam and extends into the foundation through a cutoff trench. Plate 2 shows the plan and typical cross section of the dam. The puddle clay core is five feet wide on the top and has slopes of one inch to one foot (horizontal to vertical) on each side to the surface of the ground, below which a trench five feet wide was excavated. The specifications required that the cutoff material consist of five parts screened coarse gravel, two parts fine gravel, one part sand and one part clay, thoroughly mixed. Material was to be placed in horizontal layers six inches in depth, each layer thoroughly incorporated with the material already in place. No internal drainage system was incorporated in the embankment design.

The embankment was designed to have a 2:1 (horizontal to vertical) slope on the downstream face and 2.5:1 slope on the upstream face. The upstream face of the dam was to be covered with loose stone riprap not less than eight inches deep.

(2) Appurtenant Structures. The appurtenant structures consist of the concrete ogee-type spillway, located between the left and right embankments, and the outlet works. Details of the spillway are shown

in Plates 2 and 3. The overflow section of the spillway is 37 feet wide, consisting of a central 17-foot-wide low section plus two 10-foot sections on each side, one foot above the low flow section. Concrete retaining walls were built on the downstream side of the spillway to retain the earth embankment, extending to a point 14 feet downstream from the toe of the spillway chute. As shown in Plate 3, a clay fill with a slope of 1:1.5 (horizontal to vertical) was placed on the upstream side of the concrete spillway. The spillway foundation is shown to be four to five feet below the original ground surface, founded on hard pan with a two-foot curtain wall three feet deep at the downstream toe and a three-foot cutoff wall under the upstream toe extending to impervious material.

The outlet works consist of a 15-inch-diameter cast iron pipe. The upstream end of the pipe is attached to a concrete intake structure protected with a grating. Flow through the pipe is controlled by a gate valve located at the left end of the spillway section which is operated by a 30-foot valve stem encased in a concrete gate chamber. Details of the outlet works are shown on Plate 3.

c. Design Data

(1) Hydrology and Hydraulics. A Commonwealth of Pennsylvania report entitled "Report Upon the Application of Dr. George W. Norris," dated June 26, 1915, indicates that the spillway was sized to pass a discharge of 740 cfs with the water level six inches below the top of the dam and 925 cfs with the water level at the top.

(2) Embankment. No engineering data are available on the design of the embankment.

(3) Appurtenant Structures. No engineering data are available on the appurtenant structures.

2.2 Construction. Available information indicated that construction of the dam was supervised by a field engineer from the engineering firm which designed the dam, Franklin and Company, of Philadelphia, Pennsylvania. To the extent that can be determined at this time, with certain minor exceptions, the construction of the dam was apparently conducted in accordance with the drawings and specifications prepared by the design engineer. The center section of the spillway was designed to be 20 feet wide, but field measurements indicate a width of 17 feet. In addition, the design called for riprap to be placed along the upstream face of the dam extending above the water level and in the plunge pool at the base of the spillway. Little erosion protection could be found at these locations during the field investigation. The design freeboard of four feet is close to the observed freeboard of 4.2 feet, corresponding to the low spot on the left embankment. Other information pertaining to construction of the dam is included in several construction progress reports available in the state files.

Available records indicate no major postconstruction work was performed other than repairs which were made to correct cracks and deterioration of the concrete in the spillway retaining walls.

2.3 Operation. There are no formal operating records maintained for the dam.

2.4 Other Investigations. The available information indicated no investigations other than the periodic inspections conducted by the state. The last state inspection was conducted in 1964.

2.5 Evaluation

a. Availability. The available information was provided by the Commonwealth of Pennsylvania, Department of Environmental Resources.

b. Adequacy

(1) Hydrology and Hydraulics. The available information is limited. Only the watershed area and design discharge capacity of the spillway is reported.

(2) Embankment. In view of the age of the dam (completed in 1916), it is clear that the design approach and construction techniques are not likely to have been in conformance with the currently accepted engineering practices. Design documents lack such considerations as embankment slope stability and seepage analyses. However, the design does incorporate such basic components as an impervious cutoff trench and riprap protection of the upstream slope of the dam.

(3) Appurtenant Structures. Review of the design drawings indicates that, as designed, no significant deficiencies exist that should affect the overall performance of the spillway. However, the operational condition of the outlet works needs to be confirmed.

SECTION 3
VISUAL INSPECTION

3.1 Findings

a. General. The onsite inspection of Indian Lake Dam consisted of:

1. Visual inspection of the embankment, abutments, and embankment toe.

2. Visual examination of the spillway and its components, the downstream end of the outlet pipe, and the outlet works control structure.

3. Evaluation of downstream area hazard potential.

The specific observations are illustrated in Plate 4.

b. Embankment. The general inspection of the embankment consisted of searching for indications of structural distress, such as cracks, subsidence, bulging, wet areas, seeps and boils, and observing general maintenance conditions, vegetative cover, erosion, and other surficial features.

In general, the condition of the embankment is considered to be poor. Due to thick brush, the downstream slope of the embankment could not be adequately inspected. Other than the generally poor maintenance conditions, no other significant problems with the embankment were observed.

The top of the dam was surveyed relative to the spillway crest elevation and was found to have some vertical irregularities (see Plate 5). While the design freeboard for the dam was four feet, the field survey indicated a freeboard of 4.2 feet between the low spot on the left embankment and the spillway crest.

c. Appurtenant Structures. The appurtenant structures were examined for deterioration or other signs of distress and obstructions that would limit flow. In general, the structures were found to be in fair condition. Cracks were observed in the masonry facing of the spillway and in the left and right training walls. The concrete surface of the left training wall has badly deteriorated. In addition, erosion was observed in the plunge pool near the downstream toe of the spillway. The material has eroded to a depth of approximately three feet below the concrete surface along the downstream spillway edge. The operational condition of the outlet works could not be observed.

d. Reservoir Area. A map review indicates that the watershed is predominantly wood and pasturelands. A review of the regional geology (Appendix G) indicates that the slopes of the reservoir are not likely

to be susceptible to land slides which would affect the storage volume of the reservoir.

e. Downstream Channel. The downstream channel flows approximately one-quarter mile to a highway and through a 13-foot-diameter culvert. Further description of the downstream conditions is included in Section 1.2 d.

3.2 Evaluation. In view of the deterioration of the spillway concrete and the erosion along the downstream toe of the spillway, the dam is considered to be in poor condition. Other significant conditions noted were the lack of erosion protection along the upstream slope of the embankment and thick brush on the downstream slope of the embankment which precluded adequate inspection of the dam. In addition, the operational condition of the outlet works was not observed, requiring further evaluation.

SECTION 4
OPERATIONAL FEATURES

4.1 Procedure. There are no formal operating procedures for the dam. The reservoir is normally maintained at the spillway crest level with excess inflow discharging through the uncontrolled spillway.

4.2 Maintenance of the Dam. The maintenance condition of the dam is considered to be poor. It appears that no attempts have been made to mow the grass or clear the brush from the upstream or downstream slopes. It also appears that no attempts have been made to alleviate erosion problems along the spillway toe or to repair the concrete deterioration on the spillway surface.

4.3 Maintenance of Operating Facilities. The only operating facility for the dam is the 15-inch gate valve on the outlet pipe. The gate chamber enclosing the gate valve control was locked and operation of the valve could not be observed. The owner had no knowledge regarding the operational condition of the outlet pipe valve.

4.4 Warning System. No formal warning system exists for the dam. Telephone communication facilities are available at a residence approximately one-quarter mile from the dam site.

4.5 Evaluation. The maintenance condition of the dam and the operating facilities is considered to be poor. It appears that no attempts have been made to maintain the dam or the operating equipment. Restoration of the concrete in the spillway structures, clearing of brush and trees from the dam, correction of upstream and downstream erosion problems and evaluation of the operational condition of the outlet facilities are required.

SECTION 5
HYDRAULICS AND HYDROLOGY

5.1 Evaluation of Features

a. Design Data. Indian Lake Dam has a watershed area of 2.2 square miles and impounds a reservoir with a surface area of 11.9 acres at normal pool level. Flow discharge facilities for the dam consist of a concrete ogee-type spillway structure. Based on the available head relative to the low spot on the left embankment, the capacity of the spillway is estimated to be 840 cfs with no freeboard.

b. Experience Data. As previously stated, Indian Lake Dam is classified as a small dam in the significant hazard category. Under the recommended criteria for evaluating emergency spillway discharge capacity, such impoundments are required to pass flows between the 100-year flood and one-half of the PMF. In view of the height of the dam, which is near the upper limit of the small size classification, one-half PMF was selected as the spillway design flood.

The PMF inflow hydrograph for the reservoir was determined utilizing the Dam Safety Version of the HEC-1 computer program developed by the Hydrologic Engineering Center of the U.S. Army, Corps of Engineers. The data used for the computer analysis are presented in Appendix D. As determined by the computer program, the one-half PMF inflow hydrograph has a peak of 2,533 cfs. Computer input and a summary of computer output are also included in Appendix D.

c. Visual Observations. On the date of inspection, no conditions were observed that would indicate that the spillway capacity would be significantly reduced in the event of a flood.

d. Overtopping Potential. Various percentages of the PMF inflow were routed through the reservoir and it was found that the dam can pass 10 percent of the PMF without overtopping the dam. For 50 percent of the PMF, it was found that the low area on the left embankment would be overtopped for a duration of five hours with a maximum depth of 1.8 feet.

e. Spillway Adequacy. Because the spillway cannot pass the recommended spillway design flood of one-half PMF without overtopping the dam, the spillway is classified to be inadequate.

SECTION 6
STRUCTURAL STABILITY

6.1 Evaluation of Structural Stability

a. Visual Observations

(1) Embankment. As discussed in Section 3, the field observations did not reveal any signs of distress that would significantly affect the overall performance of the structure although the condition of the dam was considered to be poor, due to lack of maintenance. Since the design lacks a positive internal drainage system, some concern exists as to the location of the phreatic surface through the embankment, as it affects the stability of the embankment and the potential for internal erosion in the event concentrated seepage develops. However, at the present time it does not appear that the phreatic surface intersects the downstream slope of the dam, and no seepage was noted.

(2) Appurtenant Structures. Significant erosion was observed in the plunge pool near the toe of the spillway. Adequate erosion protection should be placed in this area to protect the stability of the spillway structure. Cracks in the concrete were found in the spillway face and left and right training walls, and the concrete surface of the left guard wall has badly deteriorated.

b. Design and Construction Data

(1) Embankment. The dam was designed in 1916 when limited understanding of geotechnical behavior of earth structures existed. The available design and construction information does not provide any quantitative data to aid in the assessment of stability. However, as previously noted, field observations did not reveal any signs of distress that would significantly affect the stability of the embankment at this time and none were reported in the past. Therefore, based on visual observations, the static stability of the embankment is considered to be adequate.

A preliminary stability analysis was conducted to assess the stability of the gravity spillway section under normal pool, and full PMF conditions. Results indicate that the structure is stable under the loading conditions considered. Calculations are included in Appendix E.

(2) Appurtenant Structures. Other than design drawings, no design and construction data exists for the appurtenant structures. Review of these drawings indicates that there are no apparent structural deficiencies that would significantly affect the performance of the appurtenant structures.

c. Operating Records. None available.

d. Postconstruction Changes. It is reported that repairs were made to the training walls of the spillway. These modifications are not considered to affect the structural stability of the dam.

e. Seismic Stability. The dam is located in Seismic Zone 1, and based on visual observations, the static stability of the dam is considered to be adequate. Therefore, based on the recommended criteria for the evaluation of seismic stability of dams, the structure is presumed to present no hazard as a result of earthquakes.

SECTION 7
ASSESSMENT AND RECOMMENDATIONS/PROPOSED REMEDIAL MEASURES

7.1 Dam Assessment

a. Assessment. The visual observations indicate that Indian Lake Dam is in poor condition. This is due to deterioration of concrete in the spillway, a lack of erosion protection along the upstream embankment slope, erosion in the plunge pool at the spillway toe, and generally poor maintenance of the embankment and appurtenant structures.

The spillway was evaluated according to the recommended procedure and was found to pass 10 percent of the PMF without overtopping the dam. This capacity is less than the spillway design flood of one-half PMF. Therefore, the flood discharge capacity is classified to be inadequate.

b. Adequacy of Information. The available information, in conjunction with visual observations, is considered to be sufficient to make a Phase I evaluation.

c. Urgency. The following recommendations should be implemented as soon as possible or on a continuing basis.

d. Necessity for Additional Investigations. The owner should determine the nature and extent of improvements required to provide adequate spillway discharge capability and to prepare and execute plans for providing adequate erosion protection in the plunge pool at the toe of the spillway and on the upstream face of the embankment. In addition, the effects of concrete cracking and deterioration on the structural adequacy of the spillway should be determined.

7.2 Recommendations/Remedial Measures.

It is recommended that:

1. The owner should determine the nature and extent of improvements required to provide adequate spillway facilities.

2. In conjunction with the above work, investigations should be undertaken to determine the effects of concrete cracking and deterioration on the structural adequacy of the spillway structure, to evaluate erosion in the plunge pool at the toe of the spillway, and to prepare and execute plans for providing adequate erosion protection at the spillway toe and on the upstream slopes of the embankment.

3. The owner should confirm the operational condition of the outlet works and perform necessary maintenance, if found inoperative.

4. Around-the-clock surveillance should be provided during unusually heavy runoff and a formal warning system should be developed to alert the downstream residents in the event of an emergency.

5. The owner should develop a formal operating and maintenance plan for the dam, inspect the dam regularly and perform necessary maintenance.

APPENDIX A

CHECKLIST
VISUAL INSPECTION
PHASE I

APPENDIX A

CHECKLIST
VISUAL INSPECTION
PHASE I

NAME OF DAM Indian Lake COUNTY Susquehanna STATE Pennsylvania ID# NDI: PA-0057 DER: 058-038

TYPE OF DAM Earth with gravity concrete spillway HAZARD CATEGORY Significant

DATE(S) INSPECTION November 14, 1980 WEATHER Partly Cloudy TEMPERATURE 40's

POOL ELEVATION AT TIME OF INSPECTION 1389.9 M.S.L. TAILWATER AT TIME OF INSPECTION 1356 M.S.L.

INSPECTION PERSONNEL:	REVIEW INSPECTION PERSONNEL: (February 4, 1981)
Douglas Cosler	Lawrence D. Andersen
Arthur Smith	James H. Poellot
Bilgin Erel	Bilgin Erel

Owner's Representative:

Alfred Antone

Bilgin Erel RECORDER

VISUAL INSPECTION
PHASE I
EMBANKMENT

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
SURFACE CRACKS	The very thick brush on the downstream face prevented adequate inspection of the dam slopes.	Trees and brush should be cleared from the dam slopes.
UNUSUAL MOVEMENT OR CRACKING AT OR BEYOND THE TOE	None observed.	
SLOUGHING OR EROSION OF EMBANKMENT AND ABUTMENT SLOPES	None observed. However, it was noticed that the downstream slope of the earth embankment was irregular.	
VERTICAL AND HORIZONTAL ALIGNMENT OF THE CREST	See Plate 4 for dam crest profile. A small degree of settlement was observed along the top of the embankment near the left spillway edge.	
RIPRAP FAILURES	There is a very small amount of riprap on the upstream face above normal pool level.	The upstream face should be provided with erosion protection.

VISUAL INSPECTION
PHASE I
EMBANKMENT

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
JUNCTION OF EMBANKMENT AND ABUTMENT, SPILLWAY AND DAM	No problems observed. (As noted before, the downstream slope of the dam and embankment abutment junction were covered with thich brush and trees, which precluded adequate inspection of these areas.)	
ANY NOTICEABLE SEEPAGE	No noticeable seepage through the embankment.	
STAFF GAGE AND RECORDER	None	
DRAINS	None	

VISUAL INSPECTION
PHASE I
CONCRETE/MASONRY DAMS

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
ANY NOTICEABLE SEEPAGE	None	
STRUCTURE TO ABUTMENT/EMBANKMENT JUNCTIONS	No visual signs of distress. No seepage.	
DRAINS	None found.	
WATER PASSAGES	None	
FOUNDATION	No perceivable sign of distress.	

VISUAL INSPECTION
PHASE I
CONCRETE/MASONRY DAMS

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
SURFACE CRACKS CONCRETE SURFACES	Surface cracks were observed on the spillway face and left training wall. The concrete is deteriorating on the surface of the left training wall.	
STRUCTURAL CRACKING	Insignificant	
VERTICAL AND HORIZONTAL ALIGNMENT	No perceivable misalignment.	
MONOLITH JOINTS	None	
CONSTRUCTION JOINTS	No problems observed.	
STAFF GAGE OF RECORDER:	None found.	

VISUAL INSPECTION
PHASE I
OUTLET WORKS

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
CRACKING AND SPALLING OF CONCRETE SURFACES IN OUTLET CONDUIT	None observed.	
INTAKE STRUCTURE	Intake structure is below the lake water level.	
OUTLET STRUCTURE	There is no outlet structure. The outlet pipe would directly discharge to the spillway discharge channel.	
OUTLET CHANNEL	Same as spillway discharge channel.	
EMERGENCY GATE	Gate chamber was locked so that the operating condition of the gate valve could not be observed.	Owner should evaluate the operation of the gate and outlet facilities and perform necessary maintenance and repairs.

VISUAL INSPECTION
PHASE I
UNGATED SPILLWAY

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
CONCRETE WEIR	The concrete in the spillway surface and the left training wall has severely deteriorated. Cracks were also observed in the right training wall.	
APPROACH CHANNEL	Upstream of the spillway, the lake appears to be silted to approximately one foot below the crest of the spillway.	
DISCHARGE CHANNEL	Earth channel. No conditions were noted that would affect the discharge capacity of the spillway.	
BRIDGE AND PIERS	None	

VISUAL INSPECTION
PHASE I
GATED SPILLWAY

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
CONCRETE SILL	Dam has no gated spillway.	
APPROACH CHANNEL	N/A	
DISCHARGE CHANNEL	N/A	
BRIDGE PIERS	N/A	
GATES AND OPERATION EQUIPMENT	N/A	

VISUAL INSPECTION
PHASE I
INSTRUMENTATION

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
MONUMENTATION/SURVEYS	None	
OBSERVATION WELLS	None	
WEIRS	None	
PIEZOMETERS	None	
OTHER	None	

VISUAL INSPECTION
PHASE I
RESERVOIR

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
SLOPES	No problems observed.	
SEDIMENTATION	Immediately upstream of spillway overflow section, the reservoir appears to have silted to a level about one foot below the spillway crest.	
UPSTREAM RESERVOIRS	USGS Map for the area shows an upstream lake from the dam. The upstream lake was found to be a marshland.	

VISUAL INSPECTION
PHASE I
DOWNSTREAM CHANNEL

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
CONDITION (OBSTRUCTIONS, DEBRIS, ETC.)	See comments for spillway discharge channel.	
SLOPES	Steep slopes. No significant problems observed.	
APPROXIMATE NUMBER OF HOMES AND POPULATION	Three homes (approximate population = 12).	

APPENDIX B

CHECKLIST
ENGINEERING DATA
DESIGN, CONSTRUCTION, OPERATION
AND HYDROLOGIC AND HYDRAULIC
PHASE I

APPENDIX B

CHECKLIST
ENGINEERING DATA
DESIGN, CONSTRUCTION, OPERATION
PHASE I

NAME OF DAM Indian Lake

ID# NDI: PA-0057
DER: 058-038

ITEM	REMARKS
AS-BUILT DRAWINGS	Only design drawings are available.
REGIONAL VICINITY MAP	See Plate 1.
CONSTRUCTION HISTORY	The dam was designed by Franklin & Company, Civil Engineers, of Philadelphia, Pennsylvania. Construction of the dam was completed in 1916.
TYPICAL SECTIONS OF DAM	See Plate 2.
OUTLETS - PLAN - DETAILS - CONSTRAINTS - DISCHARGE RATINGS	See Plates 2 and 3.

CHECKLIST
ENGINEERING DATA
DESIGN, CONSTRUCTION, OPERATION
PHASE I

ITEM	REMARKS
RAINFALL/RESERVOIR RECORDS	None reported.
DESIGN REPORTS	Design information is available in the state files.
GEOLOGY REPORTS	None available.
DESIGN COMPUTATIONS HYDROLOGY & HYDRAULICS DAM STABILITY SEEPAGE STUDIES	Spillway design capacity calculations are available in state files.
MATERIALS INVESTIGATIONS BORING RECORDS LABORATORY FIELD	Some information on borrow material used for the embankments is provided in state files.

CHECKLIST
ENGINEERING DATA
DESIGN, CONSTRUCTION, OPERATION
PHASE I

ITEM	REMARKS
POST CONSTRUCTION SURVEYS OF DAM	None available.
BORROW SOURCES	The embankment material was borrowed from a region upstream of the dam.
MONITORING SYSTEMS	No existing monitoring systems.
MODIFICATIONS	Repairs have been made to the left training wall of the spillway. No major modifications have been reported.
HIGH POOL RECORDS	None available.

CHECKLIST
ENGINEERING DATA
DESIGN, CONSTRUCTION, OPERATION
PHASE I

ITEM	REMARKS
POST CONSTRUCTION ENGINEERING STUDIES AND REPORTS	None available.
PRIOR ACCIDENTS OR FAILURE OF DAM DESCRIPTION REPORTS	None available.
MAINTENANCE OPERATION RECORDS	None available.
SPILLWAY PLAN SECTIONS DETAILS	See Plate 2.
OPERATING EQUIPMENT PLANS AND DETAILS	See Plates 2 and 3.

CHECKLIST
ENGINEERING DATA
HYDROLOGIC AND HYDRAULIC

DRAINAGE AREA CHARACTERISTICS: 2.2 square miles (wooded)

ELEVATION, TOP OF NORMAL POOL AND STORAGE CAPACITY: 1390.0 (153 acre-feet)

ELEVATION, TOP OF FLOOD CONTROL POOL AND STORAGE CAPACITY: 1394.3 (219 acre-feet)

ELEVATION, MAXIMUM DESIGN POOL: 1394.0

ELEVATION, TOP OF DAM: 1394.2

SPILLWAY:

a. Elevation 1390.0

b. Type Ogee-type concrete structure

c. Width 37 feet (perpendicular to flow)

d. Length N/A

e. Location Spillover None observed

f. Number and Type of Gates None

OUTLET WORKS:

a. Type 15-inch-diameter cast iron pipe

b. Location Near left abutment of spillway

c. Entrance Inverts 1359± (estimated from design drawings)

d. Exit Inverts 1358

e. Emergency Drawdown Facilities 15-inch blow-off pipe

HYDROMETEOROLOGICAL GAGES:

a. Type No existing gages

b. Location N/A

c. Records None

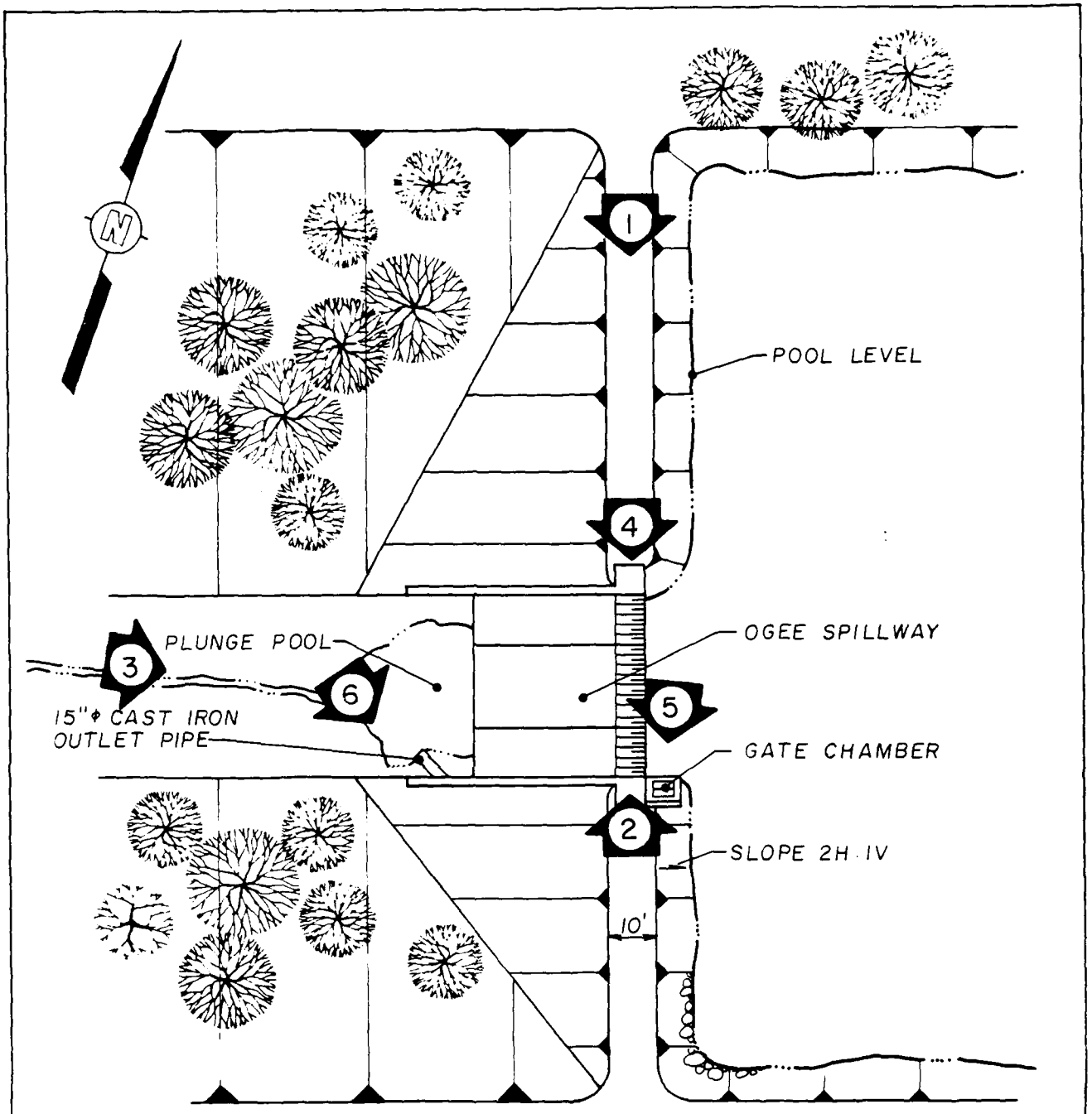
MAXIMUM NONDAMAGING DISCHARGE: Spillway capacity (842 cfs)

APPENDIX C

PHOTOGRAPHS

LIST OF PHOTOGRAPHS
INDIAN LAKE DAM
NDI I.D. NO. PA-0057
NOVEMBER 14, 1980

PHOTOGRAPH NO.	DESCRIPTION
1	Crest (looking south).
2	Right spillway abutment.
3	Spillway (looking upstream).
4	Left spillway abutment.
5	Outlet pipe valve chamber.
6	Outlet pipe (downstream end).
7	Highway culvert (mile 0.4).
8	Trailer (mile 2.6).



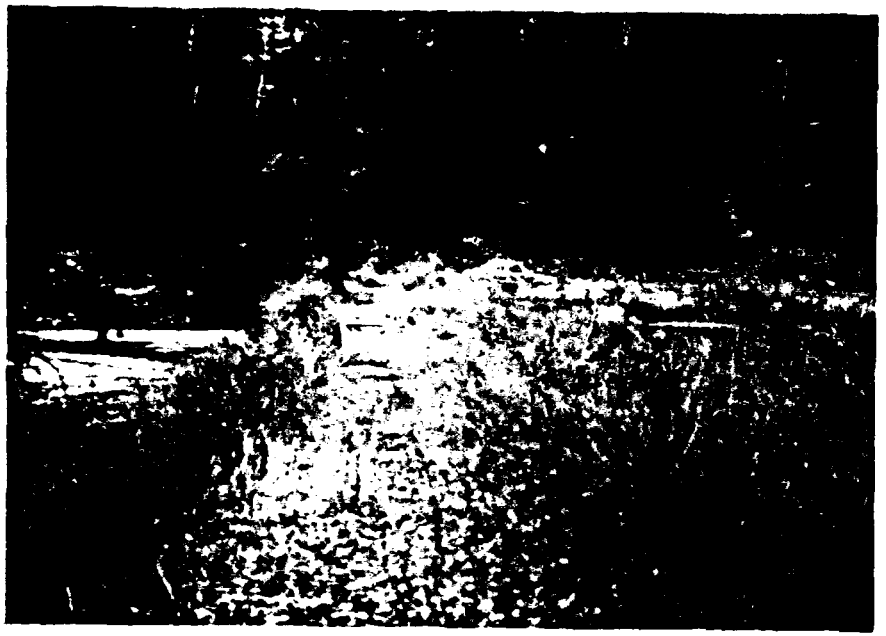
LEGEND:

2 INDICATES DIRECTION IN WHICH PHOTOGRAPH WAS TAKEN

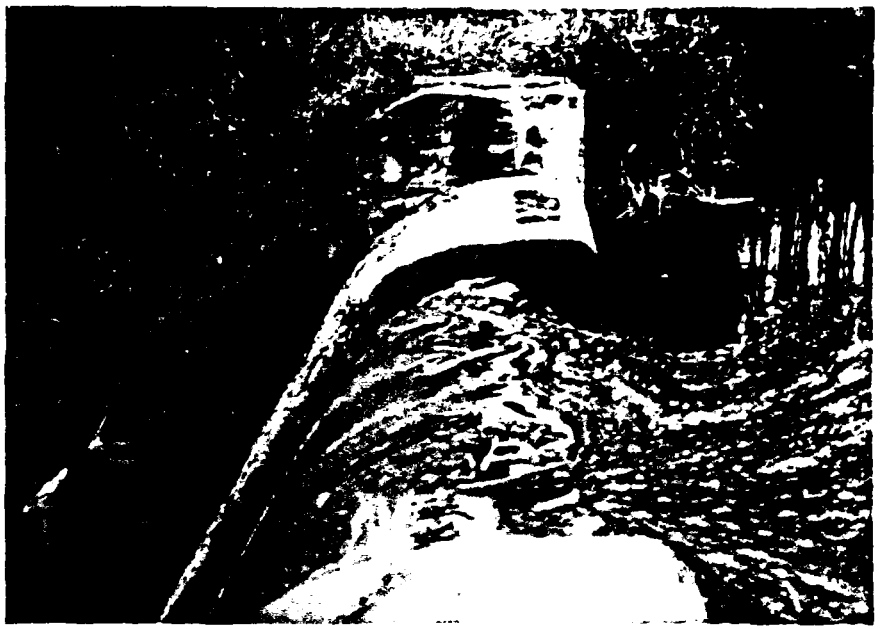
INDIAN LAKE DAM
KEY PLAN OF PHOTOGRAPHS
FIELD INSPECTION DATE NOV 14, 1980

D'APPOLONIA

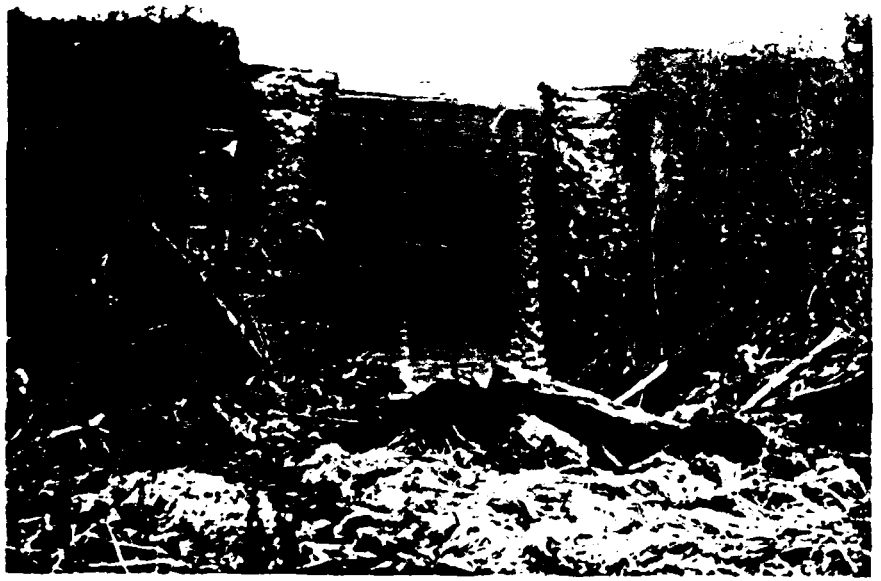
NOT TO SCALE



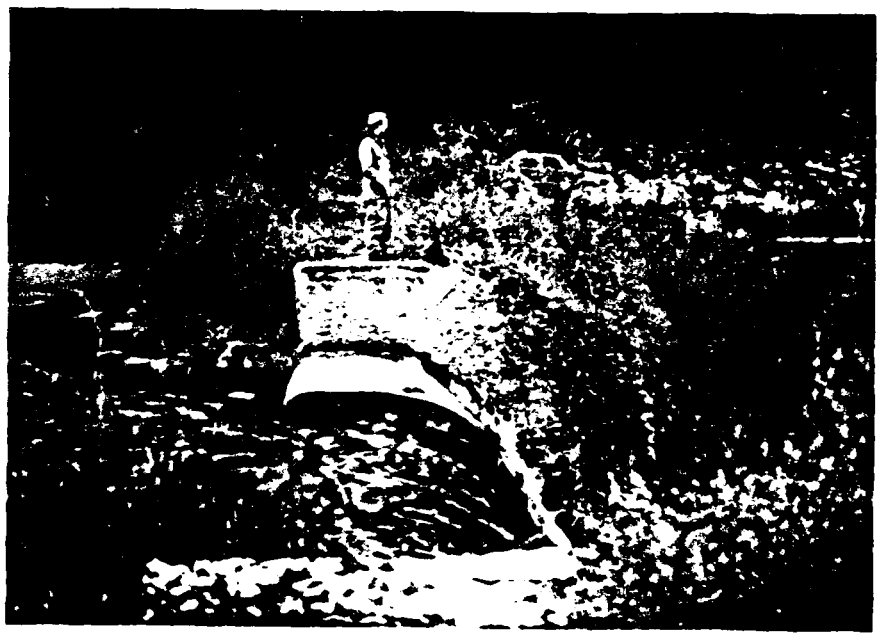
PHOTOGRAPH NO 1



PHOTOGRAPH NO. 2



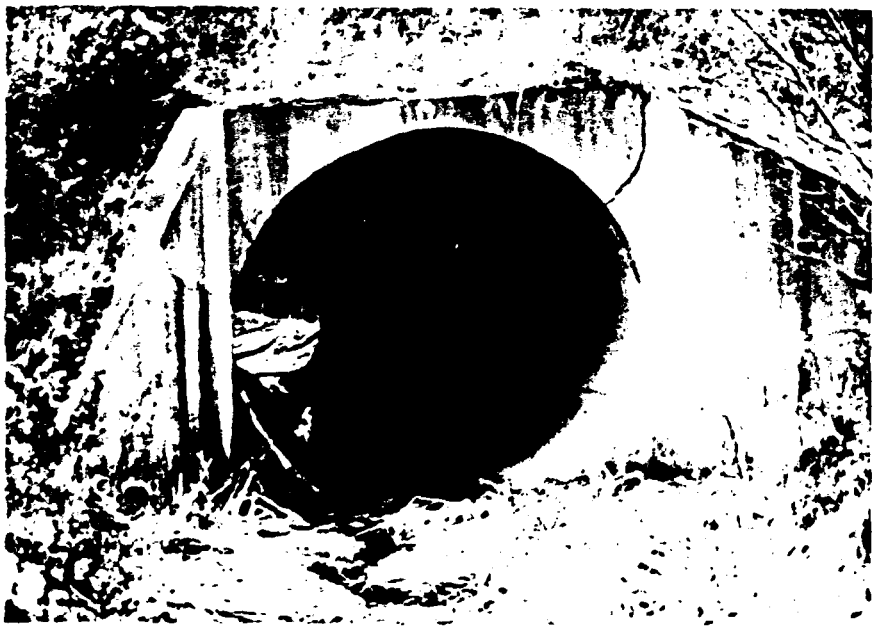
PHOTOGRAPH NO 3



PHOTOGRAPH NO 4

PHOTOGRAPH NO 5

PHOTOGRAPH NO 6



PHOTOGRAPH NO 7

PHOTOGRAPH NO 8

APPENDIX D

HYDROLOGY AND HYDRAULICS ANALYSES

HYDROLOGY AND HYDRAULIC ANALYSIS
DATA BASE

NAME OF DAM: Indian Lake Dam

PROBABLE MAXIMUM PRECIPITATION (PMP) = 22.2 INCHES/24 HOURS

STATION	1	2	3	4	5
Station Description	Indian Lake Reservoir	Indian Lake Dam			
Drainage Area (square miles)	2.17	-			
Cumulative Drainage Area (square miles)	2.17	2.17			
Adjustment of PMF for Drainage Area (%)[1]	95%				
6 Hours	117	-			
12 Hours	127	-			
24 Hours	136	-			
48 Hours	145	-			
72 Hours	-	-			
Snyder Hydrograph Parameters					
Zone[2]	11	-			
C_p/C_t[3]	0.62/1.5	-			
L (miles)[4]	2.08	-			
L_{ca} (miles)[4]	1.00	-			
$t_p = C_t(L \cdot L_{ca})^{0.3}$ (hours)	1.87	-			
Spillway Data					
Crest Length (ft)	-	37			
Freeboard (ft)	-	4			
Discharge Coefficient	-	3.1			
Exponent	-	1.5			

(1) *Hydrometeorological Report 40*, U.S. Weather Bureau, 1965.
(2) Hydrological zone defined by Corps of Engineers, Baltimore District, for determining Snyder's Coefficients (C_p and C_t).
(3) Snyder's Coefficients.
(4) L = Length of longest water course from outlet to basin divide.
L_{ca} = Length of water course from outlet to point opposite the centroid of drainage area.

STORAGE VS. ELEVATION

ELEVATION	ΔH, FEET	AREA (acres)[1]	ΔVOLUME (acre-feet)[2]	STORAGE (acre-feet)
1400		28.5		349.1
	10		196.1	
1390 (Spillway Crest El.)		11.9		153.0
	-		153.0[3]	
Reservoir Bottom		-		0

(1) Planimetered from USGS maps.
(2) $\Delta Volume = \Delta H/3\ (A_1 + A_2 + \sqrt{A_1 A_2})$.
(3) Obtained from available information.

```
**********
FLOOD HYDROGRAPH PACKAGE (HEC-1)
DAM SAFETY VERSION      JULY 1978
  LAST MODIFICATION  01 APR 80
**********
    1                 A1       SNYDER UNIT HYDROGRAPH, SPILLWAY AND DAM OVERTOPPING ANALYSES
    2                 A2       INDIAN LAKE DAM,(DER 58-38),SUSQUEHANNA COUNTY,PA.  PROJECT NO.80-556-12
    3                 A3       FOR 10%,20%,30%,40%,50%, AND 100% PROBABLE MAXIMUM FLOOD(PMF)
    4                 B     300        0       10        0        0        0        0        0       -4
    5                 B1      5
    6                 J       1        6        1
    7                 J1   0.10     0.20     0.30     0.40     0.50     1.00
    8                 K       0        1                                          1
    9                 K1       CALCULATION OF SNYDER INFLOW HYDROGRAPH TO INDIAN LAKE DAM,(DER 58-38)
   10                 M       1        1     2.17             2.17                                    1
   11                 P               21.1      117      127      136      145
   12                 T                                                      1.0      0.5             0.0086
   13                 W    1.87     0.62
   14                 X   -1.5    -0.05      2.0                                        1
   15                 K       1        2
   16                 K1       ROUTING FLOW THROUGH INDIAN LAKE DAM,(DER 58-38)
   17                 Y                                         1        1
   18                 Y1      1                                                  -1390.0       -1
   19                 Y41390.0  1390.5   1391.0   1391.5   1392.0   1392.5   1393.0   1393.5   1394.0   1394.3
   20                 Y41395.0  1396.0   1398.0   1400.0
   21                 YS    0.0     18.6     52.7    118.7    211.1    322.2    449.2    590.2    743.8    841.6
   22                 YS1085.2  1467.7   2340.7   3540.5
   23                 SA   11.9     28.5     45.0
   24                 SE1390.0  1400.0   1420.0
   25                 SS1390.0
   26                 SD1394.2     2.65      1.5    258.0
   27                 SL   25.0     50.0    100.0    137.5    161.5    211.5    228.0    258.0
   28                 SV1394.2  1394.3   1394.6   1394.7   1395.0   1395.9   1396.0   1397.1
   29                 K      99
```

PEAK FLOW AND STORAGE (END OF PERIOD) SUMMARY FOR MULTIPLE PLAN-RATIO ECONOMIC COMPUTATIONS
FLOWS IN CUBIC FEET PER SECOND (CUBIC METERS PER SECOND)
AREA IN SQUARE MILES (SQUARE KILOMETERS)

OPERATION	STATION	AREA	PLAN	RATIOS APPLIED TO FLOWS RATIO 1 .10	RATIO 2 .20	RATIO 3 .30	RATIO 4 .40	RATIO 5 .50	RATIO 6 1.00
HYDROGRAPH AT	1	2.17	1	507.	1015.	1520.	2026.	2533.	5065.
	(	5.62)	(	14.34)(	28.69)(	43.03)(	57.38)(	71.72)(	143.44)(
ROUTED TO	2	2.17	1	449.	934.	1488.	2000.	2509.	5045.
	(	5.62)	(	12.70)(	26.46)(	42.15)(	56.65)(	71.04)(	142.88)(

SUMMARY OF DAM SAFETY ANALYSIS

PLAN 1 .....

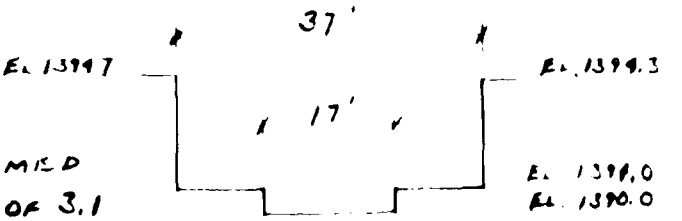
	INITIAL VALUE	SPILLWAY CREST	TOP OF DAM
ELEVATION	1390.00	1390.00	1394.20
STORAGE	0.	0.	62.
OUTFLOW	0.	0.	809.

RATIO OF PMF	MAXIMUM RESERVOIR W.S.ELEV	MAXIMUM DEPTH OVER DAM	MAXIMUM STORAGE AC-FT	MAXIMUM OUTFLOW CFS	DURATION OVER TOP HOURS	TIME OF MAX OUTFLOW HOURS	TIME OF FAILURE HOURS
.10	1393.00	0.00	42.	449.	0.00	42.17	0.00
.20	1394.50	.30	68.	934.	1.67	42.00	0.00
.30	1395.21	1.01	81.	1408.	3.67	41.67	0.00
.40	1395.66	1.46	90.	2000.	4.50	41.67	0.00
.50	1396.03	1.83	98.	2509.	5.33	41.50	0.00
1.00	1397.35	3.15	128.	5046.	7.67	41.50	0.00

DAPPOLONIA
CONSULTING ENGINEERS INC

By MB Date 1/29/81 Subject INDIAN LAKE Sheet No 1 of 1
Chkd By DX Date 1/26/81 SPILLWAY RATING CURVE Proj No 80-556-12

SPILLWAY CAPACITY



THE SPILLWAY CREST HAS AN OGEE SECTION WITH AN ASSUMED COEFFICIENT OF DISCHARGE, C, OF 3.1

THE DISCHARGE OVER AN OGEE CREST IS:

$$Q = C L H_E^{3/2} \qquad \text{(DESIGN OF SMALL DAMS, PG 373)}$$

WHERE C = COEFFICIENT OF DISCHARGE
L = LENGTH OF CREST
H_E = TOTAL HEAD, INCLUDING VELOCITY HEAD

THUS FOR THE MIDDLE SECTION:

$$Q_1 = C L_1 H_{E1}^{3/2} = (3.1)(17) H_{E1}^{3/2} = 52.7\, H_{E1}^{3/2}$$

FOR THE TWO OUTER SECTIONS:

$$Q_2 = C L_2 H_{E2}^{3/2} = 3.1(20) H_{E2}^{3/2} = 62.0\, H_{E2}^{3/2}$$

	WATER SURFACE (FT)	H_{E1} (FT)	Q_1 (CFS)	H_{E2} (FT)	Q_2 (CFS)	Q_T (CFS)
	1390.0	—	—	—	—	—
	1390.5	0.5	18.6	—	—	18.6
	1391.0	1.0	52.7	—	—	52.7
	1391.5	1.5	96.8	0.5	21.9	118.7
	1392.0	2.0	149.1	1.0	62.0	211.1
	1392.5	2.5	208.3	1.5	113.9	322.2
	1393.0	3.0	273.8	2.0	175.4	449.2
	1393.5	3.5	345.1	2.5	245.1	590.2
	1394.0	4.0	421.6	3.0	322.2	743.8
DAM CREST	1394.3	4.3	469.9	3.3	371.7	841.6
	1395.0	5.0	589.2	4.0	496.0	1085.2
	1396.0	6.0	774.5	5.0	693.2	1467.7
	1398.0	8.0	1192.5	7.0	1148.3	2340.7
	1400.0	10.0	1666.5	9.0	1674.0	3340.5

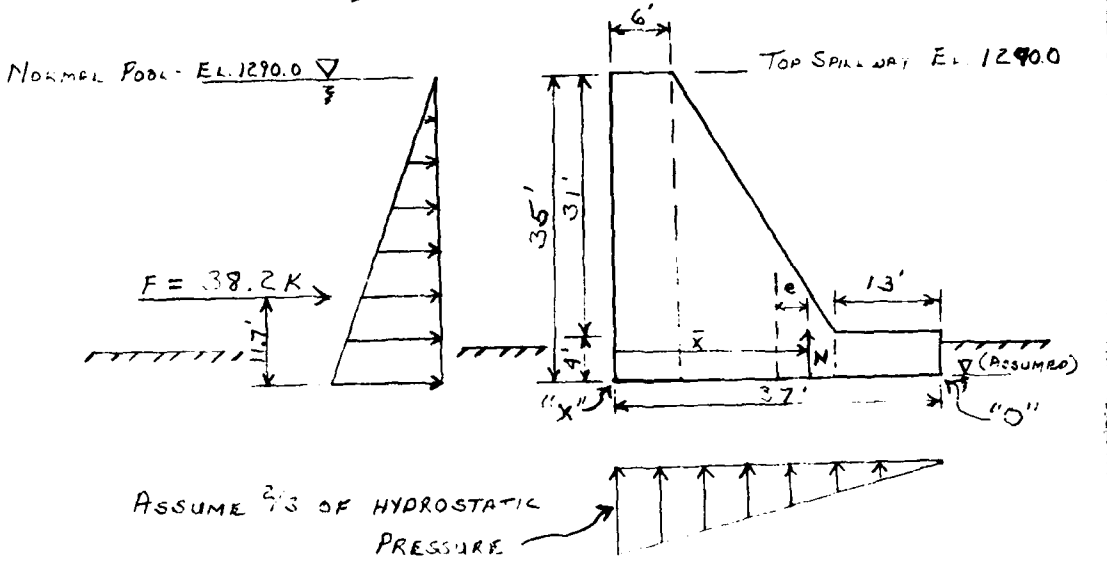
APPENDIX E

STABILITY CALCULATIONS

NORMAL POOL

STABILITY WITH RESPECT TO OVERTURNING

REF. 1: DRAWING BY FRANKLIN & CO., "PROPOSED DAM FOR DR. GEORGE W. NORRIS", NO DATE.



PRESSURE AT BASE, UPSTREAM FACE = γh
= (62.4 PCF)(35')
= 2184.0 PSF
= 2.2 KSF

TOTAL FORCE, $F = \frac{1}{2}\left(\frac{2184\ PSF}{1000\ PSF/KSF}\right)(35') = 38.2\ K/FT$

FOR A 1 FOOT HORIZONTAL SECTION, F = 38.2 K

THE UPLIFT PRESSURE AT THE BASE OF THE SPILLWAY IS ASSUMED TO VARY FROM 2/3 THE HYDROSTATIC PRESSURE AT THE HEEL, POINT "X", TO ZERO AT THE TOE, POINT "O".

REF. 2: CORPS OF ENGINEERS MANUAL, EM 1110-2-2200, "GRAVITY DAM DESIGN", SEPT. 25, 1958.

UPLIFT PRESSURE AT HEEL = 2/3 (2184.0 PSF) = 1456.0 PSF
UPLIFT PRESSURE AT TOE = 0

UPLIFT FORCE, F_U = 1/2 (1456.0 PSF)(37.0') = 26,936 LB/FT
= 26.9 K/FT

FOR A 1 FOOT HORIZONTAL SECTION, F_U = 26.9 K

FACTOR OF SAFETY AGAINST OVERTURNING

$$= \frac{\text{RESISTING MOMENTS ABOUT "O"}}{\text{OVERTURNING MOMENTS ABOUT "O"}}$$

RESISTING MOMENTS:

[(4.0')(37.0')(0.150 K/FT³)] x 18.5' = 410.7 FT-K

[1/2 (31.0')(18.0')(0.150 K/FT³)] x 25.0' = 1046.3 FT-K

[(31.0')(6.0')(0.150 K/FT³)] x 34.0' = 948.6 FT-K

Σ 4056 FT-K

OVERTURNING MOMENTS:

38.2 K x 11.7' = 446.9 FT-K

26.9 K x 24.7' = 664.4 FT-K

1,111.3 FT-K

$$F.S. = \frac{2905.6}{1111.3}$$

= 2.2 O.K.

FOUNDATION SHEARING STRESS $= \frac{38.2K}{37.0'} = 1.03\ KSF = \underline{7.2\ PSI}$

STABILITY WITH RESPECT TO SLIDING

PER REF. 2: THE RESULTANT MUST FALL IN THE CENTRAL 1/3 OF THE BASE WIDTH AND THE MAXIMUM SLIDING FACTOR, $\Sigma H/\Sigma V$, IS 0.65.

$\Sigma H = 38.2\ K$

$\Sigma V = [(4')(37') + (\frac{1}{2})(31')(18') + (31')(6')](0.150\ K/FT^3) - 26.9K$
$= 920 - 26.9$
$= 65.1\ K$

SLIDING FACTOR $= \Sigma H/\Sigma V = \frac{38.2}{65.1}$

$= \underline{0.59 < 0.65}$ O. K.

LOCATE RESULTANT ON BASE

$\Sigma M_x = 0$ $\circlearrowleft^+$, $N = \Sigma V = 65.1\ K$

$N\bar{x} = (11.7')(38.2K) + (3')(27.9K) + (12')(91.9\ K) + (18.5')(22.2K) - (12.3')(26.9K)$

$\bar{x} = 1112.3/65.1$
$\bar{x} = 17.1'$

$\underline{12.3 < \bar{x} < 24.7}$ OK

FOUNDATION PRESSURES

$e = 17.1 - 18.5 = -1.4'$ (MINUS SIGN INDICATES HEEL SIDE)

AVERAGE BEARING STRESS = $\Sigma V/A = 65.1/37.0$
$= 1.76$ KSF
$= 12.2$ PSI

STRESS DUE TO MOMENT = $e\Sigma V/S = (1.4)(65.1)/(37^2/6)$
$= 0.90$ KSF
$= 6.2$ PSI

AT THE HEEL

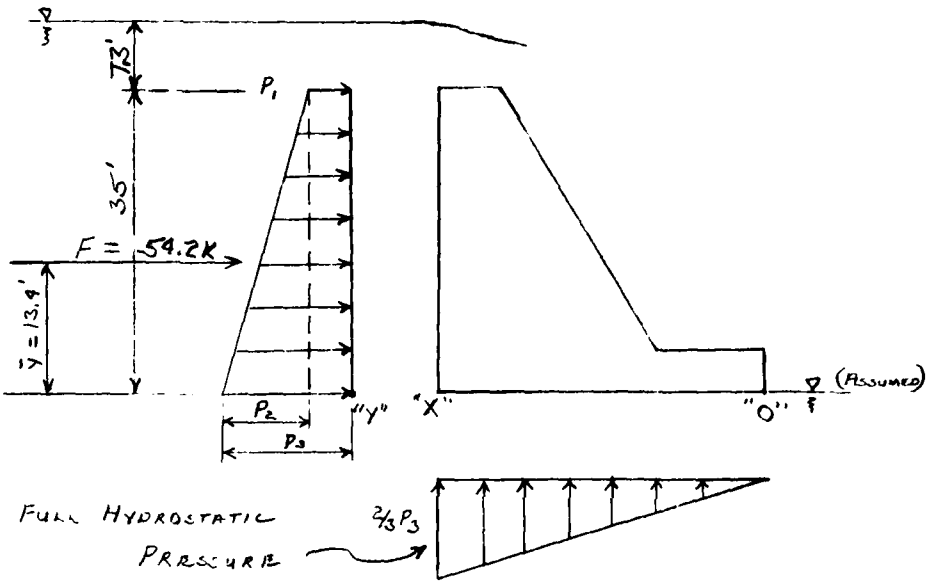
$q_{MAX} = 15.0$ PSI

AT THE TOE

$q_{MIN} = 9.4$ PSI

OVERTOPPING OF SPILLWAY 7.28' DUE TO PMF (REF 3)

STABILITY WITH RESPECT TO OVERTURNING



ASSUME 2/3 OF FULL HYDROSTATIC PRESSURE

$P_3 = \gamma h = (62.4)(42.3) = 2640$ PSF , $\frac{2}{3} P_3 = 1760$ PSF

$P_1 = (62.4)(7.3) = 456$ PSF

$P_2 = P_3 - P_1 = 2184$ PSF

TOTAL FORCE, $F = 35(456) + \frac{1}{2}(35)(2184) = 15,960 + 38,220$

$= 54,180$ LB

$= \underline{54.2\ K}$

$\Sigma M_y = 0$

$F\bar{y} = (17.5')(15,960) + 11.7(38,220)$

$\bar{y} = 726474 / 54180$

$\bar{y} = \underline{13.4}$

REF. 3: PMF OVERTOPPING ANALYSIS BY HEC-1 COMPUTER PROGRAM, RUN I.D. - AFJAMVB1, DATED 1/20/81

$F_4 = \frac{1}{2}(1760)(37) = 32,560$ LB
$= 32.6$ K

FACTOR OF SAFETY AGAINST OVERTURNING

RESISTING MOMENT = 2405.6 FT-K (FROM PAGE 2)

OVERTURNING MOMENTS:

54.2K x 13.4'	=	726.3 K-FT
32.6K x 24.7'	=	805.2 K-FT
		1531 K-FT

F.S. = 2405.6/1531.5
= 1.57 OK

FOUNDATION SHEAR STRESS = 54.2/37
= 1.46 KSF
= 10.2 PSI

STABILITY WITH RESPECT TO SLIDING

$\Sigma H = 54.2$K

$\Sigma V = 92.0$K (FROM PG. 3) $- 32.6$K
$= 59.4$ K

SLIDING FACTOR = 54.2/59.4
= 0.91 > 0.65 NO GOOD

PER REF. 2, SLIDING FACTOR OF SAFETY MUST BE CHECKED

REF. 4: C.O.E., ETL 1110-2-184, "GRAVITY DAM DESIGN STABILITY", FEB 25, 1974.

THE SLIDING RESISTANCE, R, IS

$$R = \Sigma V \tan\phi + S A$$

AND $$F.S. = R/\Sigma H > 4$$

ASSUME FAILURE OCCURS AT THE ROCK-CONCRETE INTERFACE, FROM REF. 5, THIS LEADS TO THE LOWEST VALUE OF S.

A TYPICAL VALUE OF BOND STRENGTH BETWEEN ROCK AND CONCRETE IS 120 PSI.

REF. 5: ROSENBURG & JOURNEAUX, "FRICTION AND END BEARING TEST FOR HIGH CAPACITY SOCKET DESIGN", CANADIAN GEOTECHNICAL JOURNAL, 1976.

ASSUME $\tan\phi = 0.25$ AND $S = 60$ PSI, SINCE DAM WAS BUILT IN 1915.

$$R = 59.4(0.25) + 60(35)\tfrac{144}{1000}$$
$$= 317.3\ K$$

$$F.S. = 317.3/54.2$$
$$= \underline{5.9 > 4} \quad OK$$

LOCATE RESULTANT ON BASE

$$\Sigma M_x = 0$$

$$N\bar{x} = (13.4')(54.2K) + (3')(27.9K) + (12')(41.9K) + (18.5')(22.2K) - (12.3')(32.6$$

$$\bar{x} = 1322.5/59.6$$

$$\bar{x} = 22.2'$$

$$\underline{12.3 < \bar{x} < 24.7} \quad O.K.$$

FOUNDATION PRESSURES

$e = 22.2' - 18.5 = 3.7'$ (TOE SIDE)

AVERAGE BEARING STRESS $= 59.6/37 = 1.61$ KSF
$= 11.2$ PSI

STRESS DUE TO MOMENT $= 3.7(59.6)/(37^2/6)$
$= 0.97$ KSF
$= 6.7$ PSI

AT THE TOE

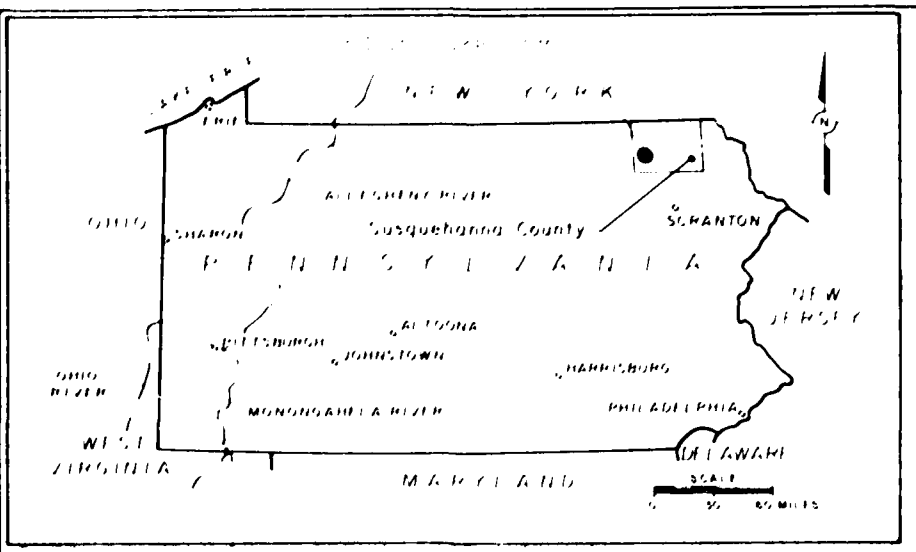
$q_{MAX} = 17.9$ PSI

AT THE HEEL

$q_{MIN} = 4.5$ PSI

APPENDIX F

PLATES



KEY PLAN

HIGHWAY UND
(13'Ø CULVE

REFERENCES

1. U.S.G.S. MONTROSE WEST, PA QUADRANGLE PHOTOREVISED 1978, SCALE 1:24000
2. U.S.G.S. SPRINGVILLE, PA QUADRANGLE PHOTOREVISED 1969, SCALE 1:24000

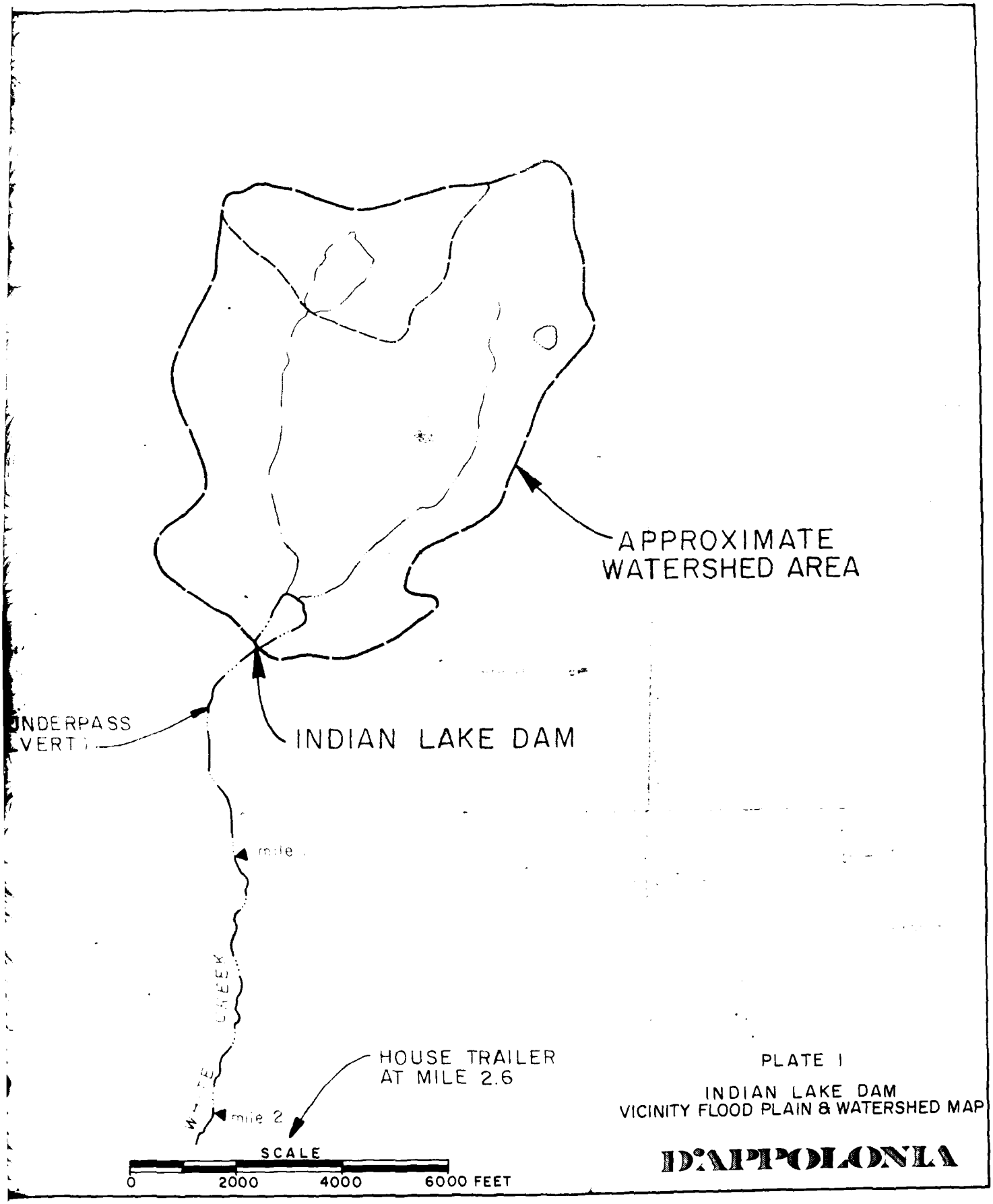
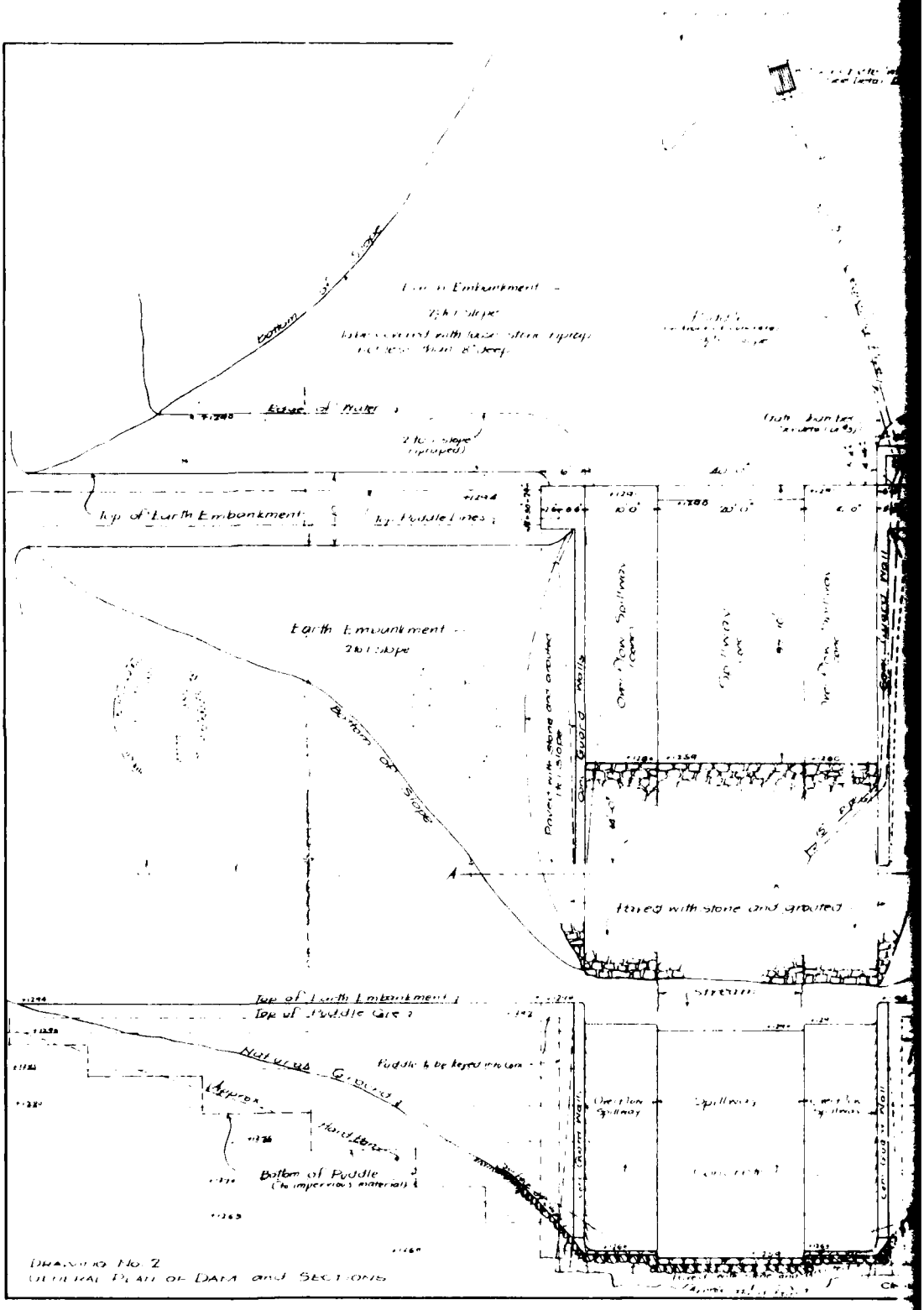


PLATE I

INDIAN LAKE DAM
VICINITY FLOOD PLAIN & WATERSHED MAP

DAPPOLONIA

DRAWN BY	ACS	CHECKED BY	JSC	2-17-81	DRAWING NUMBER 80-556-B6
	12-15-80	APPROVED BY	JTH	2-17-81	



DRAWING No. 2
GENERAL PLAN OF DAM and SECTIONS

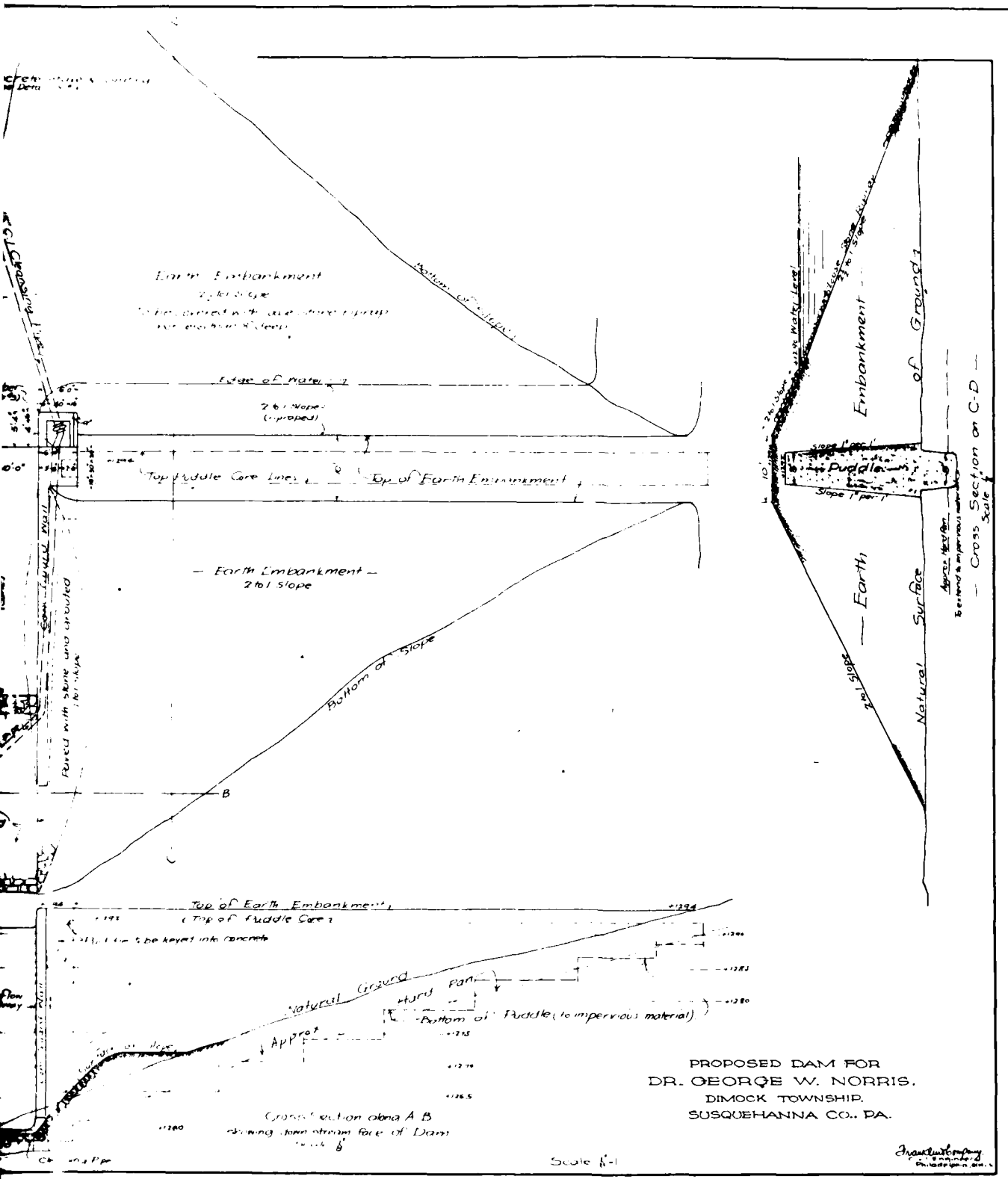
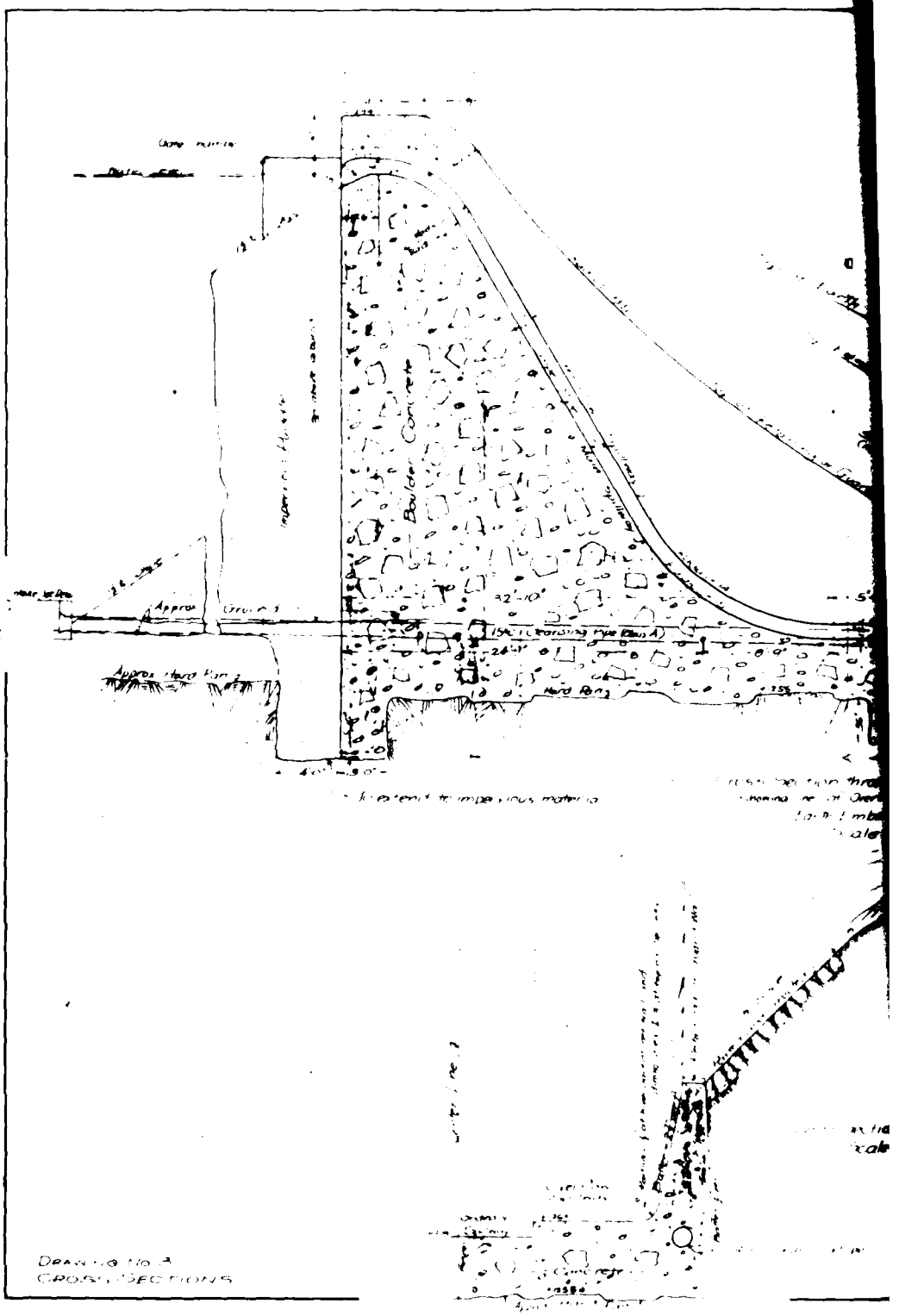


PLATE 2

DRAWN BY	ACS	CHECKED BY	JSE	2-17-81	DRAWING NUMBER 80-556-B7
	2/15/80	APPROVED BY	[illegible]	2-19-81	



DRAWING NO 3
CROSS SECTIONS

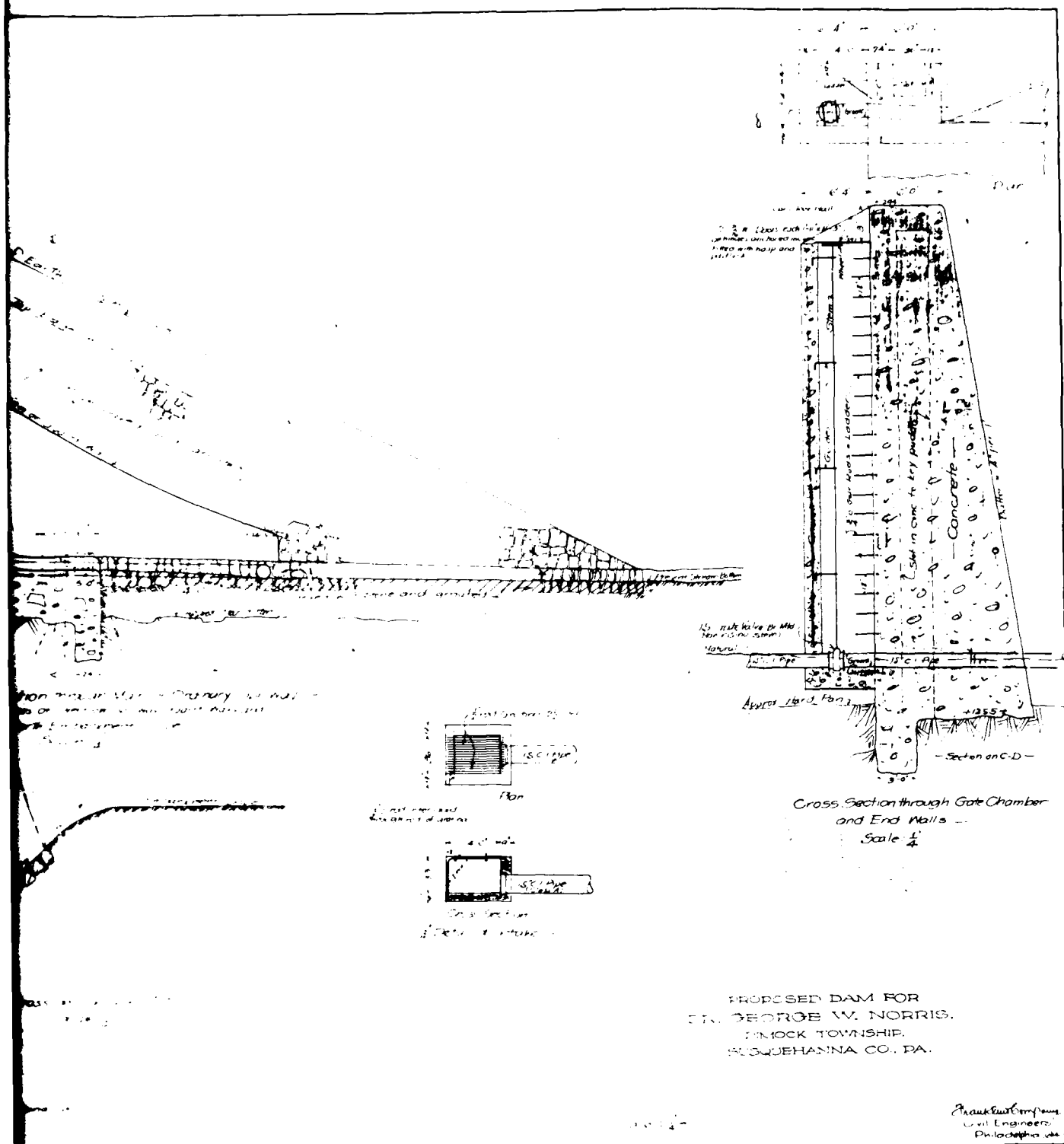
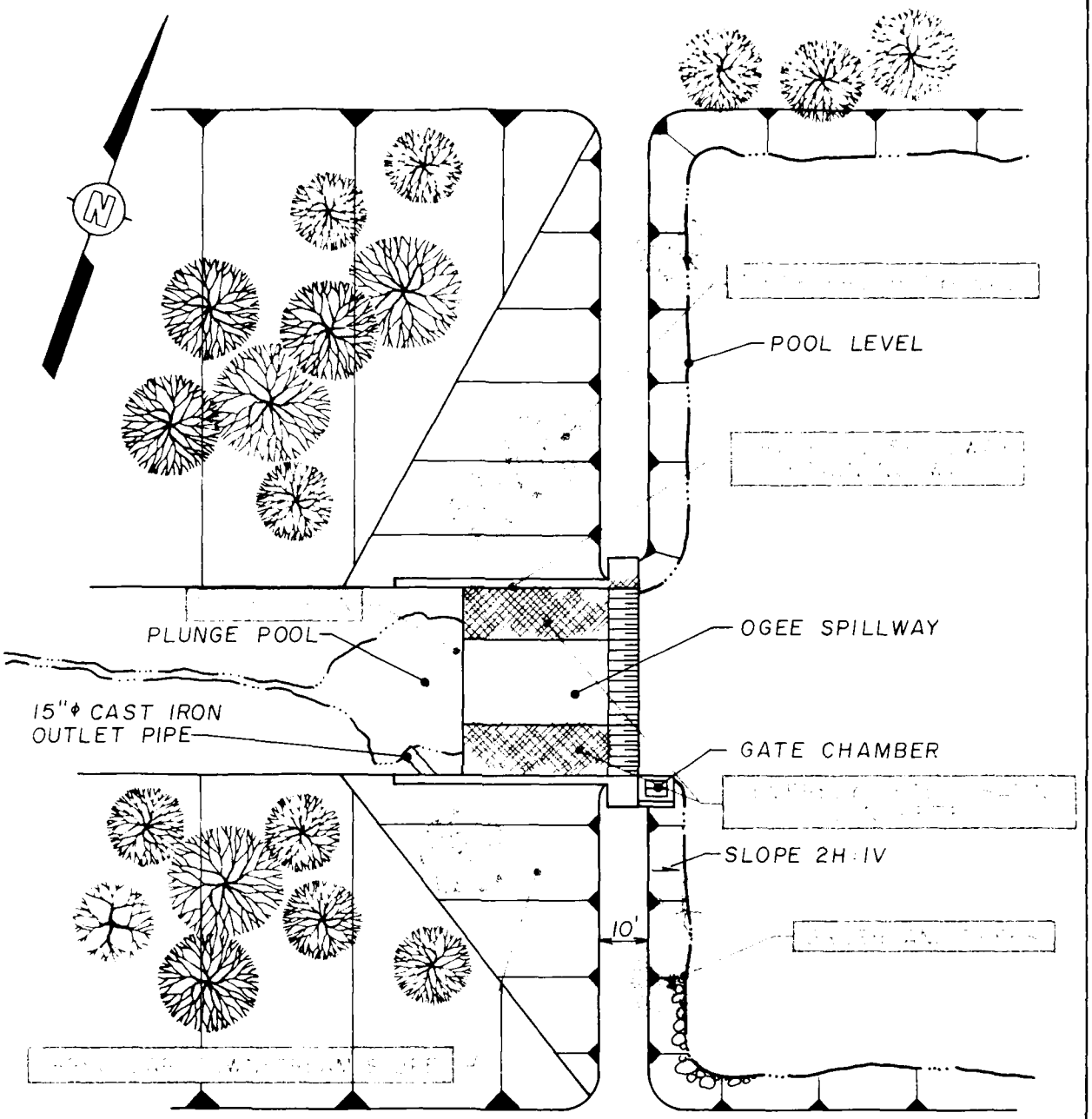


PLATE 3

DRAWN BY	ACS	CHECKED BY	BE	2-17-81	DRAWING NUMBER 80-556-A13
	11-18-80	APPROVED BY	JHD	2-17-81	



NOTE

POOL LEVEL AT DATE OF INSPECTION
AT LOW FLOW SPILLWAY CREST

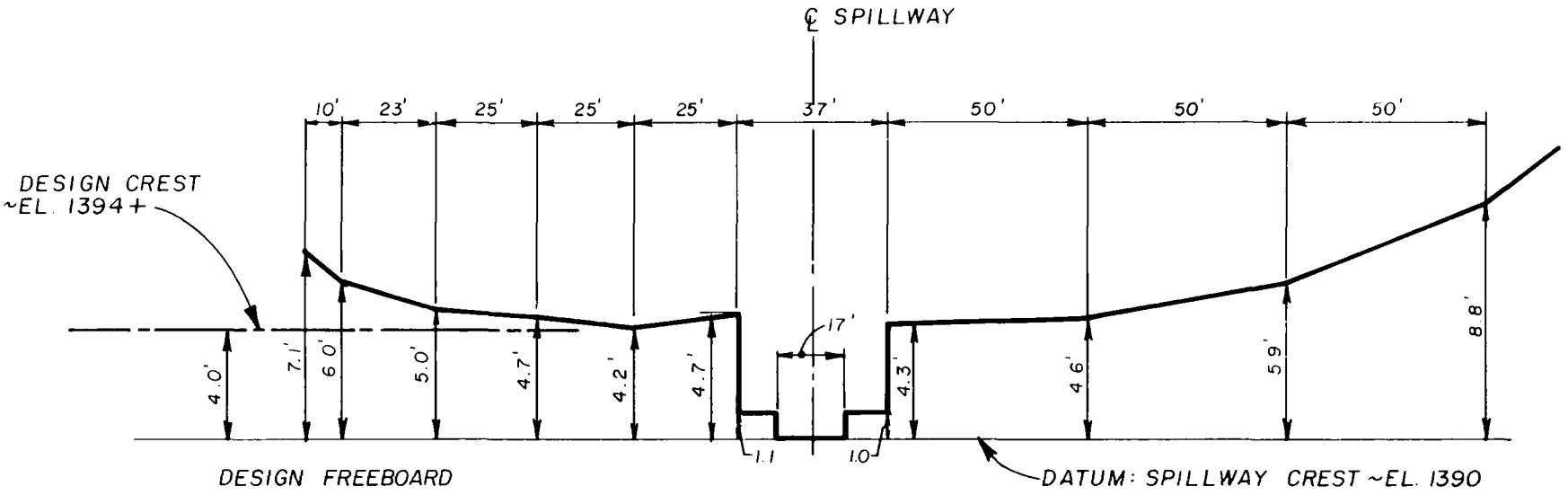
PLATE 4

INDIAN LAKE DAM
GENERAL PLAN
FIELD INSPECTION NOTES
FIELD INSPECTION DATE NOV. 14, 1980

DIAPOLANA

NOT TO SCALE

DRAWN BY	sh. 12-26-80	CHECKED BY / APPROVED BY	SC / JHP	2-17-81 / 2 17 81	DRAWING NUMBER	80-556-A14



DAM CREST PROFILE

(LOOKING DOWNSTREAM)

NOTES:

1. DAM CREST WAS SURVEYED RELATIVE TO SPILLWAY CREST LEVEL.
2. DATUM ELEVATION WAS INTERPOLATED FROM USGS MAPS, THEREFORE IS APPROXIMATE.

PLATE 5

INDIAN LAKE DAM
DAM CREST SURVEY
FIELD INSPECTION DATE NOV. 26, 1980

DAMPLONA

APPENDIX G

REGIONAL GEOLOGY

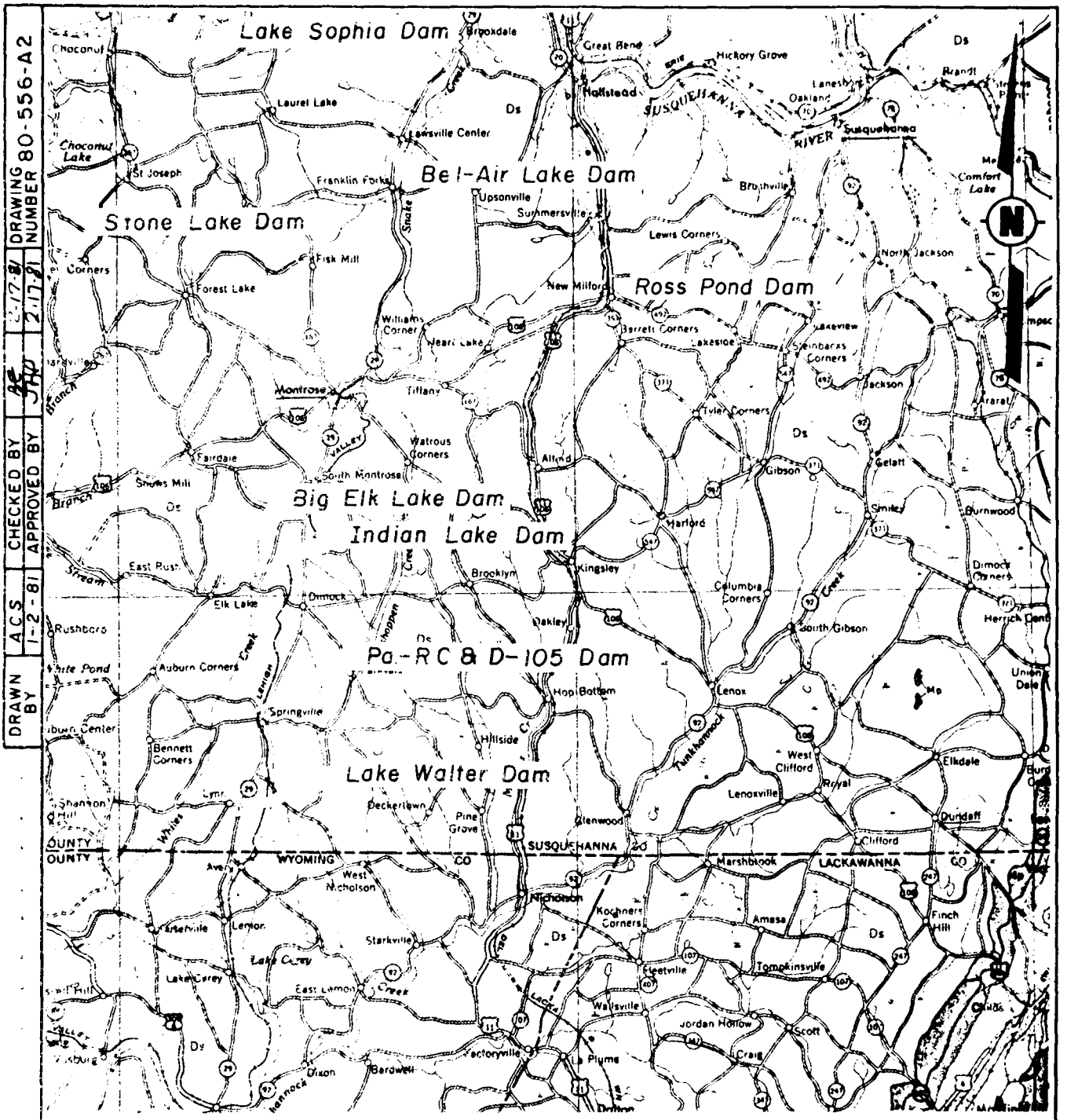
REGIONAL GEOLOGY
BIG ELK LAKE AND INDIAN LAKE DAMS

The Big Elk Lake and Indian Lake dams are located in the glaciated low plateaus section of the Appalachian Plateau physiographic province, characterized as a mature glaciated plateau of moderate relief.

The geologic structure consists of a series of northeast trending folds (approximately N70°E) which plunge gently to the southwest. The dip of the limbs of the folds in the vicinity of the dams is less than two degrees, with the southeast limb steeper than the northwest limb. The dams are located near the axis of a small syncline between the Wilmot and Towanda anticlines. In general, the discontinuity trends are northeast and northwest.

The stratigraphy consists of glacial till which will range in thickness from very thin to approximately 200 feet. The glacial till is underlain by the Devonian Catskill Formation, which is approximately 1,800 feet thick in this area. The Catskill Formation is continental in origin, consisting of red shale, cross-bedded red and green sandstone and siltstone. The shale strata tend to weather rapidly when exposed.

DRAWN BY	CHECKED BY	DRAWING NUMBER
A.C.S.	APPROVED BY	80-556-A2
1-2-81	JHD 2-17-81	



SCALE

0 2 4 6 8 10 miles

GEOLOGY MAP

REFERENCE

GEOLOGIC MAP OF PENNSYLVANIA PREPARED BY COMMONWEALTH OF PENNA, DEPARTMENT OF ENVIRONMENTAL RESOURCES, DATED 1960
SCALE : 250,000

D'APPOLONIA

PENNSYLVANIAN

APPALACHIAN PLATEAU

Ps — Allegheny Group

[illegible] includes Freeport, Kittanning and Clarion Formations

Pottsville Group

Predominantly sandstones and conglomerates with thin shales and coals; some coals mineable locally.

ANTHRACITE REGION

Pp — Post-Pottsville Formations

[illegible] coals

Pottsville Group

Light gray to white [illegible] sandstones and conglomerates [illegible] able coal; includes Sharp Mountain, Schuylkill, and Tumbling Run Formations

MISSISSIPPIAN

Mmc — Mauch Chunk Formation

Red shales [illegible] at the [illegible] Pennsylvania

Pocono Group

[illegible]

DEVONIAN

UPPER

CENTRAL AND EASTERN PENNSYLVANIA

Doo — Oswayo Formation

Brownish and greenish gray, fine and medium grained sandstones with some shales and scattered calcareous lenses; includes red shales which become more numerous eastward. Relation to type Oswayo not proved

Dck — Catskill Formation

Chiefly red to brownish shales and sandstones; includes gray and greenish sandstone tongues named Elk Mountain, Honesdale, Shohola, and Delaware River in the east

Dm — Marine beds

Gray to olive brown shales, graywackes, and sandstones; contains "Chemung" beds and "Portage" beds including Burket, Brallier, Harrell, and Trimmers Rock; Tully Limestone at base.

Ds — Susquehanna Group

[illegible] is "Chemung-Catskill" contact of Second Pennsylvania Survey County reports; barbs on "Chemung" side of line.

GEOLOGY MAP LEGEND

D'APPOLONIA

REFERENCE.

GEOLOGIC MAP OF PENNSYLVANIA PREPARED BY COMMONWEALTH OF PENNA, DEPARTMENT OF ENVIRONMENTAL RESOURCES, DATED 1960
SCALE 1:250,000

DRAWN BY	ACS	1-2-81	CHECKED BY	[illegible]	2-17-81	APPROVED BY	[illegible]	2-17-81	DRAWING NUMBER	80-556-A4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